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Long Days or Many Years?

A FRIEND takes me to task for suggesting a longer working day. If it takes a man an hour to get from his home to his desk or workbench and an hour to get back, he is putting in two hours a day plus his railroad or car-fare to earn a day's pay. If he works a longer day and earns proportionately greater wages, his expense in time and transportation will be a smaller proportion of his earnings, and his net income will be greater.

But there is another bearing to the question.

Suppose one works for a contractor and drives a team of horses. The horses have to be fed and stabled, and interest and depreciation has to be paid on the cost of the outfit whether it does any work or not. If it works ten hours a day instead of eight, it should do 25 per cent more work. The contract would be completed in a shorter time. The interest on the money locked up in it would be less, and the cost of the completed job would be smaller.

Replace the team by a factory. With its equipment it costs a lot of money. The interest on this investment, depreciation, insurance, taxes, heating, lighting, the costs for administration, non-productive labor, as cleaners, watchmen, etc., go on whether the factory turns out much or little.

If it turned out twice as much, the cost of this overhead per unit of production—and in some lines it is a large proportion of the total cost—would be cut in two.

If the product were sold at cost plus a fair profit, its selling price would be less and the workman, who is probably directly or indirectly a consumer of such product, would, if he worked longer hours and helped to get the larger production, get just as much per hour, more per day and, if the system were of general application, a reduced cost of living.

He would receive considerably more money and have to spend considerably less of it for his current livelihood. The rest, properly invested, would provide for his declining years.

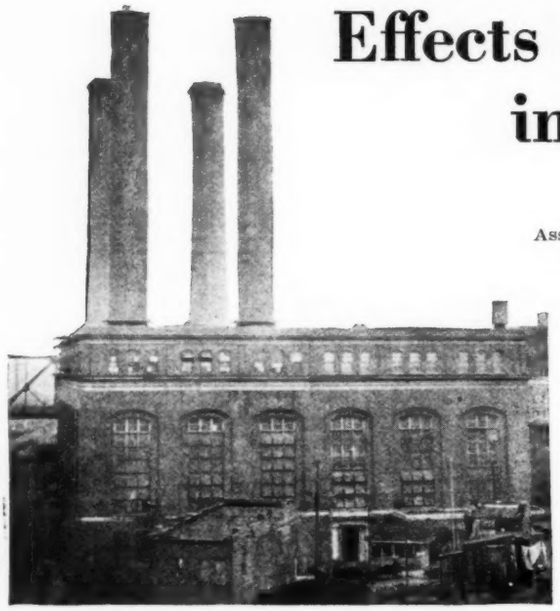
The collective savings of workmen available for investment would bring about a collective proprietary interest of labor in the tools of industry.

But if everybody worked all his life and long enough per day to get a big use factor out of the equipment, we could produce, with our modern methods and machinery, more than we need.

And so I was led to wonder whether, in a model industrial system, it would not be better for men to work longer days but a shorter number of years; to be put to work later in life and spend their old age in comfort and with an assured income.

The money that they can earn in a certain number of hours will keep them all their lives. Is it better to earn it all during their prime, or to spread their term of service out, by shortening the working day, over the time when they ought to be in school and the time when failing power increases the burden of enforced extension of their years of toil?

F. R. Low



Effects 35 Per Cent Reduction in Generating Cost

By D. E. DRUEN,
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Changes in operating practices and the building up of an efficient personnel, with an intimate knowledge of daily performance, have resulted in an average saving of $1,000 a day in the 50,000 kw. station of Kansas City Railways. Although 20 years old, the station performance now compares favorably with many modern plants

THERE are many antiquated plants scattered over the country which still offer unrecognized possibilities of economies, and it is not an exaggeration to say that taking advantage of these latent economies by operators working with old equipment will enable many of them to reduce generating costs close to those of stations erected during the last ten years.

Such a problem was encountered in the Missouri River Power Plant of the Kansas City Railways, and the results accomplished, although the work is not yet finished, have amply justified the efforts put forth. The Kansas City Railways passed into the hands of receivers September, 1920, and in line with reducing operating expenses of the property as a whole, an endeavor was made, beginning Jan. 1, 1921, to effect economies in power generation. A further reason why every possible economy should be practiced was the fact that the newly completed station of the Kansas City Power & Light Co. had taken over practically all the commercial load formerly supplied from the railway plant. In 1920 the energy sales amounted to more than 40 per cent of the total, and in 1921 a drop to about 17 per cent was faced. This meant that besides the loss of the profit on the sales, the plant would be operating at a load factor from 8 to 10 per cent lower and that there was a decreased total generation over which to distribute many of the operating charges. The decrease in the load gave the opportunity to overhaul equipment that in the past had been loaded to the limit to maintain service.

The station was built twenty years ago with an initial installation of three 3,000-kw. generators directly connected to vertical compound engines taking steam from ten 5,750-sq.ft. water-tube boilers. This equipment was added to until in 1910 the installation as it exists today was completed. The station now has, in addition to the three engine-driven units, which are used only in emergencies, two 15,000-kw. vertical turbines and two 10,000-kw. horizontal turbines of later design. These four turbines are all equipped with old-type square condensers having tubes 1¼ and 1½ in. in diameter arranged in solid nests. It is characteristic of condensers of this type that there is a rapid falling off to the vacuum with an increase in the circulating water temperature and a considerable depression of the hotwell temperature during the winter months. The circulating water, which is drawn from the Missouri River, carries considerable silt in suspension and ranges in temperature from 33 deg. F. in the winter to 84 deg. F. during the hot months of the summer. Under these circumstances and the best conditions of loading it is possible to obtain from the turbines water rates ranging from 14.8 to 15.8 lb. per kilowatt-hour.

The boiler room contains 40 water-tube boilers arranged on two floors, one directly above the other. There are two rows of ten boilers each facing on a common firing aisle. Twelve boilers on the first floor are fitted with old-style underfeed stokers and the remaining eight have natural-draft chain grates. On the upper deck nine more boilers also have the chain grates, while the stokers have been removed from the other eleven and oil burners installed. All the boilers still have the original head room of 8 ft. from the floor to the bottom of the front tube header, giving a furnace volume of 6.6 cu.ft. per square foot of grate area for the underfeed stokers and 3.4 cu.ft. for the chain grates. Steam is generated at 185 lb. pressure with 85 deg. of superheat.

In 1921, on account of the various fields from which fuel was procured, coal showed only a fair B.t.u. value. The balanced average was 9,574 B.t.u. per lb. The average analysis of the coal as fired was as follows: Fixed carbon, 44.2 per cent; volatile, 25.1 per cent; ash, 18.8 per cent; moisture, 11.9 per cent. In 1920 the average calorific value of the fuel used was 9,670 B.t.u. per lb. and last year it ran about 9,460.

This brief description of the plant furnishes a general idea of the equipment in the station as it exists today and as it was on Jan. 1, 1921, when steps were first taken to reduce production costs. What savings have been obtained were effected without the addition of any new apparatus with the exception of a master steam gage, three boiler-feed-pump regulators and a centrifugal oil purifier, all representing an investment of perhaps $2,500.

It is difficult to figure accurately what savings have been brought about as a result of the general housecleaning and the adoption of an organized program of operation based on an analytical study of conditions in the Missouri River plant. It is estimated that if operating costs that prevailed in 1920, when the plant was

running under more favorable conditions as to load factor, total generation and quality of coal, were applied to 1921 conditions of load, the cost would have exceeded the actual amount spent by $275,000. The same computation made for the year 1922 shows a saving of $450,000. This makes a total saving in 24 months of about $725,000, or an average of about $1,000 a day. Such a comparison seems conservative when it is considered that the price of coal for both years was practically the same and of lower B.t.u. content in 1921 than in 1920, that the load factor was from 8 to 10 per cent lower and the annual output about 31 per cent less. However, coal was slightly cheaper last year than in 1920, but the average load factor was not quite as good as in the previous year and the total generation ran a little behind that of 1921.

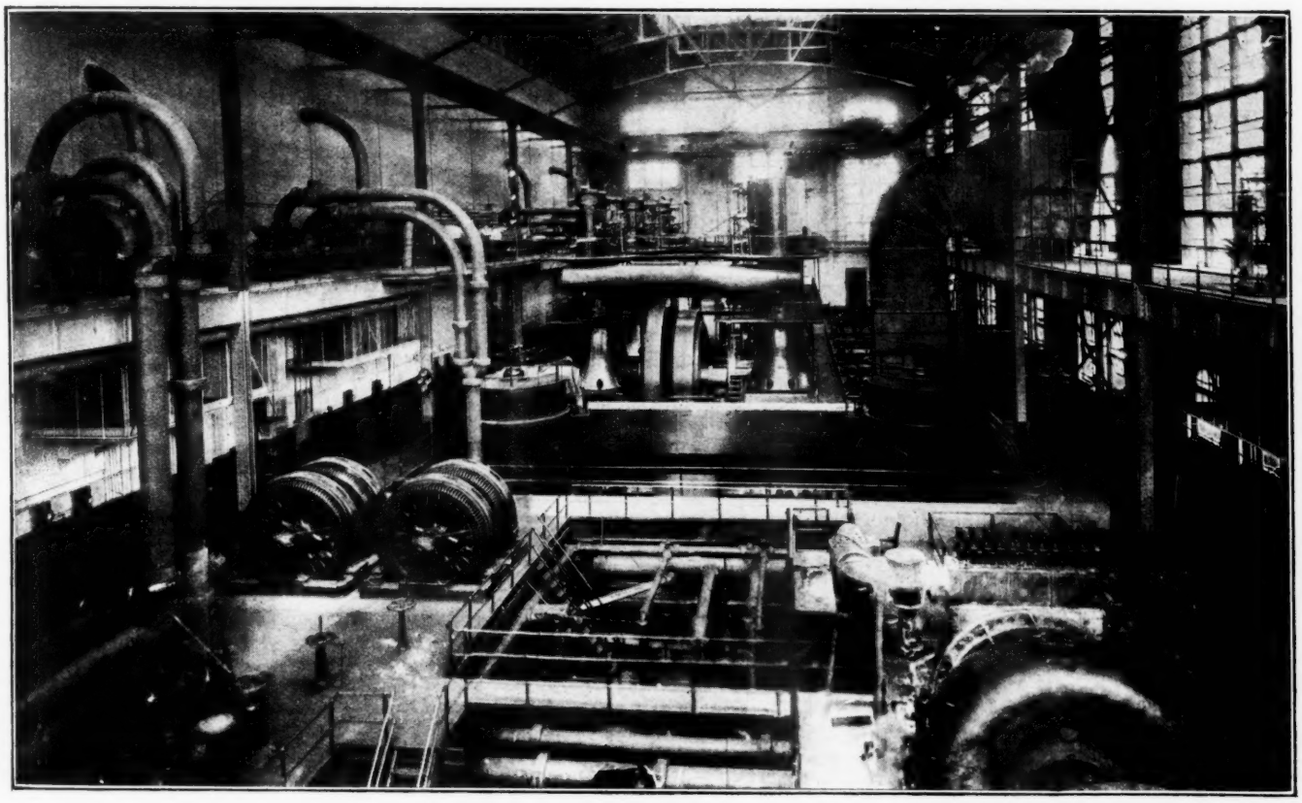


FIG. 1—VIEW OF TURBINE AND ENGINE ROOM

During 1921 the coal required per kilowatt-hour was reduced on the average about 0.52 lb., as compared with 1920, and a further reduction of 0.68 lb. was effected in 1922. The actual weight of coal per kilowatt-hour is now running 1.2 lb. below the average of two years ago. The increased economy meant a real saving of around 38,000 tons in 1921 and about 68,000 tons in 1922, or a total of 106,000 tons in 24 months. The B.t.u. per kilowatt-hour are now running about 12,000 less than two years ago, which represents about 1.1 lb. of coal. Coupled with this saving are those in every other part of the plant operation, so that in 1922 we have been producing a kilowatt-hour on the average at a reduction of 35 per cent compared with 1920 costs. The lowest figure reached so far was in December, 1922, when the cost per unit dropped 47 per cent under the average for 1920.

An examination of the accompanying curves shows how the tendency has been since new operating practices were established for the thermal efficiency to go up and for costs to decrease. There are certain limits of efficiency of the station imposed by the economy of existing equipment, and it is estimated that without the addition of more economical limits the irreducible minimum will be reached by the end of this year. This figure has been carefully calculated, and the entire plant organization is directing its efforts to this end. A successful start is indicated by operating costs in January of 1923, which were lower than any reached in the year 1922.

When operation of the plant was started at the beginning of 1921 under the new régime, it was apparent that a radical departure from practices in vogue would have to be made and that remedies determined upon would have to be applied without delay. The initial efforts were directed toward an investigation to learn what could be done quickly to insure continuity of service. The fact that the station had suffered 52 service interruptions in 1920, varying from a few minutes to two hours, made the immediate solution of this difficulty imperative. A careful analysis covering these interruptions, supplemented by additional information gathered from the station operators, revealed the various sources of most of the troubles. Every energy was immediately turned to the elimination of the faults responsible. This involved hasty repairs to auxiliary equipment, the overhauling and adjusting of machine governors, oil switches, disconnects, control wiring, feed lines, boiler-feed pumps, etc. Rigid rules were laid down for the regular inspection of every unit, and operating methods were adopted that not only would tend to minimize the possibility of a service interruption but also would make possible the re-establishment of

service with the least delay. Every cause of breakdown was sought out and either eliminated or provision made to lessen the hazard. As a net result of the efforts expended along this direction, the station has had but three interruptions since Jan. 1, 1921. The maximum tie-up, which lasted about 19 minutes, was due to an error in switching and not to the failure of any piece

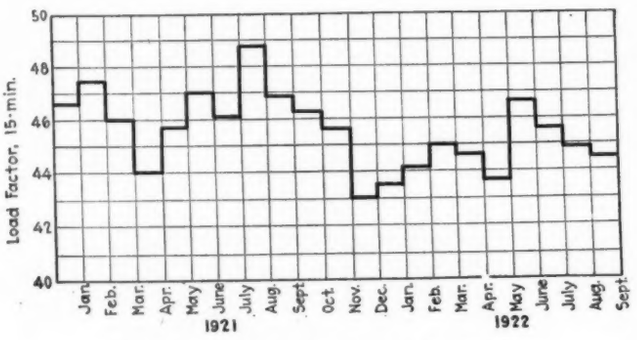


FIG. 2—VARIATION IN LOAD FACTOR

of apparatus. This record was the benefit derived from making deferred repairs and by enforcing rigid operating rules.

Building an Organization

Attention was next directed toward the building up of an efficient and capable operating organization, and this phase of the work has been most interesting and fruitful. It would have been a comparatively easy task to form a group capable of continuing operation of the plant at about the same economy that existed and do nothing but improve the service reliability. But in addition it was necessary that the thermal efficiency of the station be brought to the maximum possible with the equipment available. Maintenance on the building and equipment, which had been deferred for years, had to be completed. Radically different operating methods had to be adopted. Old traditions and customs that had become laws had to be wiped out. In fact, so much had to be changed that it was at first thought that the most feasible plan would be to replace quietly and quickly the major portion of the station employees. But the fact that among the number were many old and loyal men worthy of every chance and assistance led to the abandonment of this plan, and instead it was decided to work up the new organization, if possible, from those already employed. The present employees are made up almost entirely from the men in service during 1920. In December of that year 360 men were regularly employed in the station, and it was estimated that 170 men would be sufficient.

One of the most difficult things we had to do was to develop an entirely new attitude in the minds of the men toward the station. They had become listless and absolutely disinterested in the success or failure of the plant. They had little or no knowledge of operating costs and accepted service interruptions and equipment failures as a mere incident in the day's work.

While this process of elimination was going on, another line of investigation was being carried out to determine easier and better methods of doing work and of increasing the labor output per man. The result of these studies enabled us to hand-pick the crews a third time and get rid of the non-essential workers. The effect of the third reduction in forces reflected on the weekly payroll curve during March, 1921. Reductions in the force made after this period were effected by further improvement in operating methods and through a careful study of the traits and characteristics of individual employees. Some men were found to be incapable of adapting themselves to the changed conditions and they were weeded out and dismissed.

From that time on, no employees were dismissed before they were critically studied. The physical and mental fitness was considered and the attitude of each toward his fellow workmen and the company was observed. The rate at which these changes in organization were made and the effect of the force reductions is indicated on the accompanying graphs, Fig. 3.

Force Reduced to Less Than Half

At the end of 24 months of this organization building we find that 150 men now comprise our entire station force as compared to the 360 of 1920. This force of 150 men have brought deferred maintenance on building and equipment up to date and have made it possible for the station to render practically 100 per cent service at a unit cost for power in December, 1922, 47 per cent less than the average for 1920. Probably the one great factor that made it possible for these men to accomplish what they have, was the changing of their attitude from the defensive to the offensive.

A visitor will find that almost anyone in the station from the chief engineer down can tell him the exact number of pounds of coal per kilowatt-hour required last month and the month previous. Any oiler could tell him which shift in the plant used the most oil on auxiliaries during the month just passed. One can turn to any operator and obtain information as to the pro-

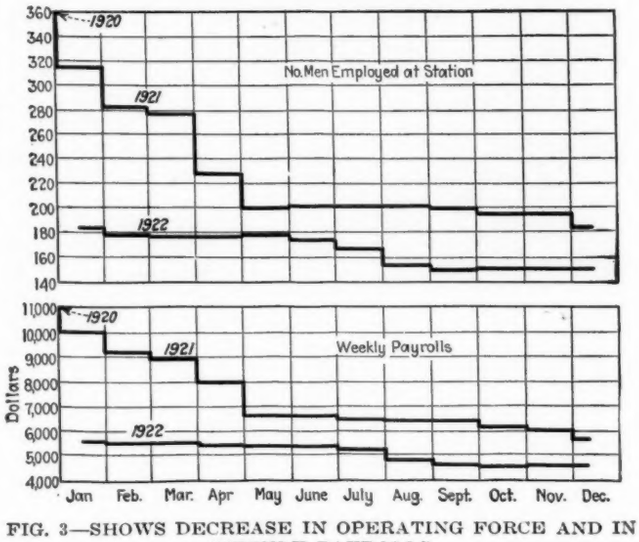


FIG. 3—SHOWS DECREASE IN OPERATING FORCE AND IN WEEKLY PAYROLLS

gress of the station in general, this month as compared with last month or with a year ago. At the messroom one would find the plant superintendent, chief engineer, firemen, oilers and ash handlers all having noonday lunch together. We have endeavored to produce an organization that would operate as one large family with the common incentive of ever decreasing the cost of producing a kilowatt-hour. A power-plant committee composed of five representatives chosen from the workmen and five from the engineers and foremen, with the plant superintendent as chairman, handle all matters

pertaining to wages and working conditions, welfare and safety. This committee meets twice a month.

While the work of building up the operating personnel and physical condition of the plant was under way, considerable progress was being made in improving the thermal efficiency of the station. As every operator knows the greatest possibilities for increasing economy

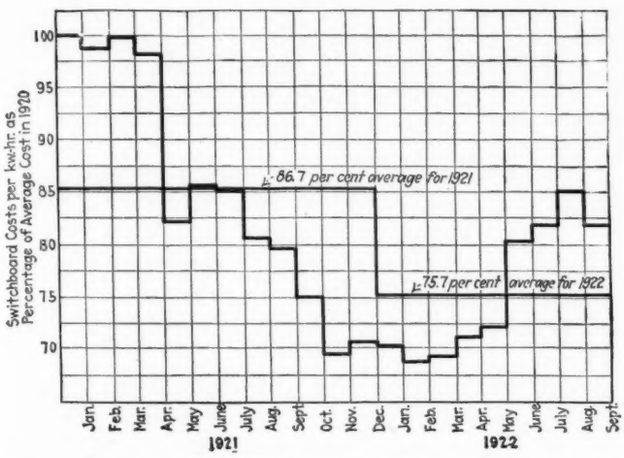

Switchboard Costs per kw-hr. as Percentage of Average Cost in 1920
86.7 per cent average for 1921
75.7 per cent average for 1922
1921
1922

FIG. 4—ECONOMIES REFLECTED IN SWITCHBOARD COST

of a given installation exist in the boiler room. We collected data from a series of boiler tests on the losses in warming up and banking of the boilers and on their efficiency at various loads. On the basis of this information a method of boiler dispatching has been established which reduces banked boiler-hours to a minimum and allows the boilers to be operated at a rating to produce the maximum boiler efficiency, the maintenance of the furnace and stoker considered.

These tests showed that it was not economical to force the boilers to a rating much above 150 per cent because of the limited combustion space, and there are enough boilers so that it is hardly ever necessary to exceed this rating. It had been former practice to operate the boilers at 180 to 200 per cent of rating, at which point the efficiency had dropped considerably. At these higher ratings, gas passages and furnace volumes were too small, and as a result, when operating at ratings much over 150 per cent, furnace and stoker maintenance reached an abnormal figure, ashpit losses were large and considerable trouble was experienced with slag on the boiler tubes.

Makeup Water Localized

Four of the 40 boilers have been arranged to be served by an independent feed pump and heater, so that all makeup water may be passed through these boilers. All scale deposits are thereby confined to them and scale-free water is fed to the remaining boilers. The makeup water, which is drawn directly from the city mains, averages from 16 to 20 grains of hardness and is treated with soda ash in a proportion to neutralize as nearly as possible the scale-forming tendency. We are just beginning to realize the benefits of this scheme and expect to make a material saving in fuel by it in a short time. A sand filter box into which all blowoff water is discharged, has produced a substantial saving by conserving scale-free water. Largely as a result of this method the city water bill has been reduced from an average of $1,800 a month to $850, and by using the generator air washers to reduce the temperature of lubricating oil and jacket cooling water, we anticipate reducing the city water bill to approximately $400 per month in 1923.

By the adoption of the various methods and schemes described, the average boiler efficiency has been raised from 59 to 67 per cent. Four oil-burning boilers are being revamped for more efficient combustion, and they will be used over the peak loads, thereby reducing the number of banked boiler hours on the coal-fired boilers. All fuel and ash are analyzed and the ash analyses are grouped by samples taken from boilers fired by the different men. The results are tabulated and posted in the boiler room so that every man knows what he is doing.

Generator dispatching has been carefully worked out

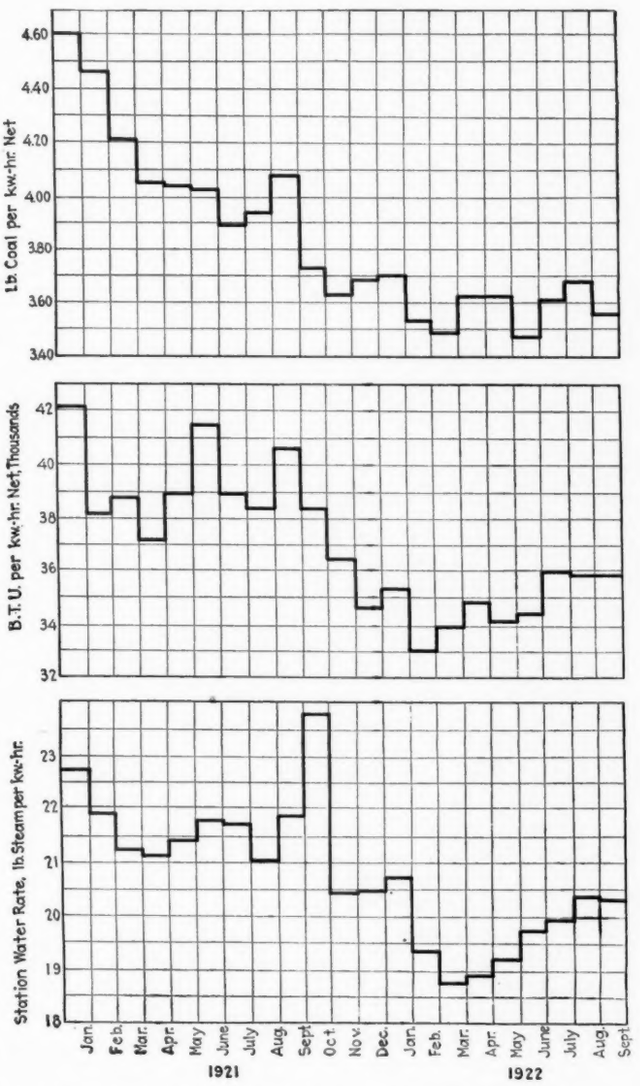


FIG. 5—SHOWS STATION PERFORMANCE DURING 1921 AND 1922

on a B.t.u. input-output basis, and economies from this source are already apparent. According to this method the most economical unit carries the base load and the other units are put on the line in the order of their water rates for the additional load to be furnished. As it is possible to predict the load with considerable accuracy a day in advance, the probable load curve is drawn each day and against it is plotted the correct

time of connecting and disconnecting machines from the line. On the same sheet a similar curve is drawn indicating the number of boilers and the time for them to be put on the line. Having been prepared in advance, these curves act as a guide for the station operators. On the day following a bulletin is posted commenting on the previous day's operation and giving suggestions as to how the handling of the boilers and turbines can be improved.

Each morning all data covering the previous day's operation are figured and plotted on three large curve sheets. The curves which are carried out for a complete month, are posted each morning with the figures of the day before. The data on these sheets include the gross generation, boiler horsepower hours in service, total evaporation, station water rate, individual machine water rates, combined machine water rate, plant load factor, machine load factors, average barometer, temperature of circulating water, individual machine vacuums, water evaporated per boiler horsepower-hour, average kilowatt-hours per boiler horsepower-hour, and total evaporation. At the end of each month a comparative report is prepared showing the station efficiencies. This statement is circulated throughout the plant and compared by the men with the operation of previous months.

Further Economies Contemplated

To get operation down to the point we expect to reach, we have planned several schemes, none of which will involve the purchase of additional equipment. We contemplate obtaining a better balance by bleeding two of the turbines to the heater through thermostatic control valves. Plans have also been prepared for steam laneing in the condenser by the removal of tubes. In this way steam can reach the lower tubes, the surface of which can then act as effective condensing area rather than cooling the steam already condensed. From this change we expect a slight increase in vacuum, and also a decrease in the depression of the hotwell temperature.

A lubrication survey has been made which indicates the cost of lubrication may be reduced about 50 per cent. Details will be given in a later article.

Also an analysis has been made covering all packings used in the station with the view of reducing the number of types and grades of packing necessary. Charts will be drawn showing the grade and size required for any particular location and the mandrils will be provided for cutting the packing to the exact size. A scheme has been worked out by which we have standardized all valves for all types of service from 2½-in. sizes to the smallest in use. As a result of studying the amount of fan maintenance material necessary to have on hand, the stores stock has been reduced by about two-thirds.

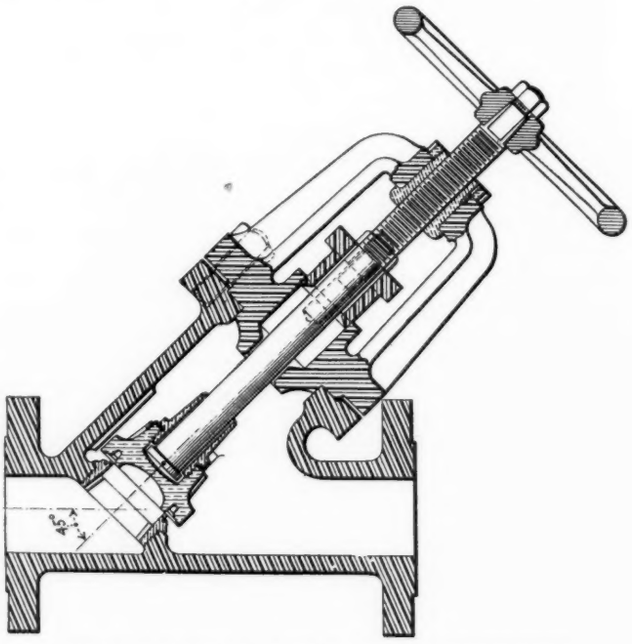
Some time soon, it is planned to install an evaporator for handling the makeup feed water and also assist in maintaining the proper heat balance. It is estimated that the savings will pay for the cost of the evaporator in a few months.

While it may appear that the results as shown could have been accomplished in a less time than two years, it must be borne in mind that the re-organization of the plant forces involved much more than a reassembling of men under different lines of authority. It is the efficiency of this human machine that has made possible all the savings effected so far, and that will ultimately develop and utilize every available economy up to the limit of the station's possibilities.

Straightway Blowoff Valve for High Pressures

To meet the demand for a straightway blowoff valve that will conform with the A.S.M.E. Boiler Code, the Edward Valve & Manufacturing Co., of East Chicago, Ind., has produced a valve of this type in the one standard size of 2½ in. for working pressures up to 400 lb. gage. It has a flanged outside-stem-and-yoke bonnet, the valve stem making an angle of 45 deg. with the axis of the pipe line. The body and bonnet are of electric cast steel and the internal working parts of monel metal.

As required for blowoff valves, the pressure at all times is at the bottom of the disk. The valve construction is of the Edward protected type in which the inner plug portion of the disk enters the extended lip of the seat ring, while the seating surfaces farther out on the disk and seating ring are still comparatively far apart. As the clearance between the plug and the ring is only a few thousandths of an inch, foreign matter, such as scale or sediment, is held back while the water that still may be blown through, washes off any accumulation on the seat or disk during the final closing of the valve. This may be accomplished more readily as the seating surfaces are narrow, and being formed on raised projections on seat and disk, the valve may be reground without increasing the width of the seat.



NEW BLOWOFF VALVE FOR HIGH PRESSURES

In preparing the pipe ends for electric resistance welding, care must be taken to have clean surfaces of contact, and square ends without burrs or upsetting, so as to assure a solid weld through the full cross-section of the metal and to avoid a reduction of area of flow. While the current heats the pipe ends to a welding temperature, pressure is being applied to force the ends together until a complete union or weld is effected. The slight upsetting on the outside is smoothed down by a pair of tongs, the jaws of which are bored out to conform to the outside diameter of the pipe.

Automatic Balancer Substation for Elevator Service

Multi-Voltage Supplied for Control of Elevator Machines by Three Automatic Balancer Sets—Two Machines Are in Operation, but Should One Fail This Unit Is Cut Out of Service and Another Cut In Automatically

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AUTOMATIC station-control equipment has been so successful in meeting the requirements of systems for the generation and utilization of electric power as to encourage engineers to apply it to a continually increasing number of new uses. One of the latest of these is its application to the control of the balancer substation used in supplying direct-current power to the multi-voltage elevator system of the new Standard Oil Building, New York City. This substation, which recently went into operation, is especially interesting because of certain unusual features, both in the switching equipment and in the machines themselves, made necessary by the requirements of the service. The automatic control is arranged for both local or remote starting and stopping of each unit by means of master switches. All the operating sequences involved in putting the machines on or cutting them off the line, protection, and the transfer of machines in emergencies, are performed automatically.

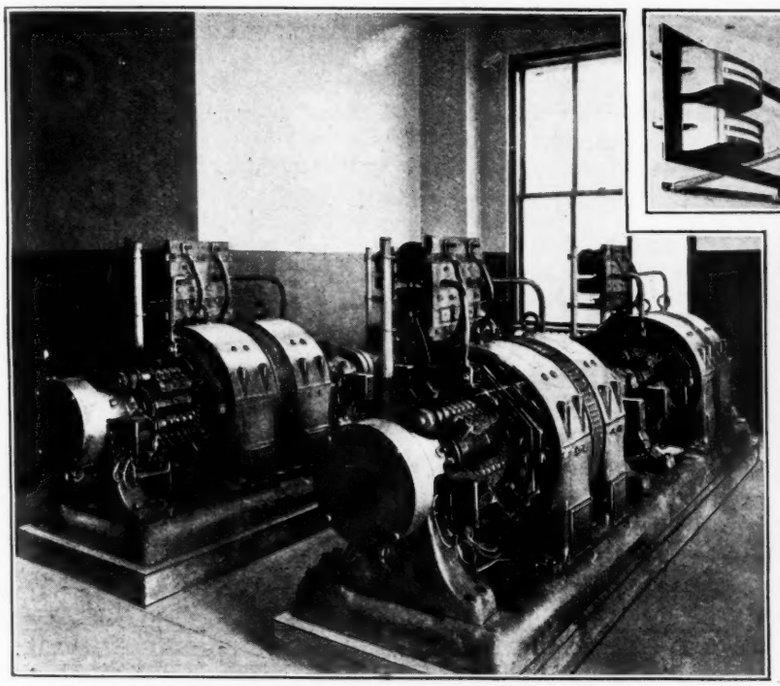


FIG. 1—TWO OF THE THREE BALANCER SETS, EACH SET CONSISTING OF FOUR 60-VOLT MACHINES

FIG. 2—AUTOMATIC CONTROL PANELS FOR BALANCER SETS

The complete equipment of the substation consists of three compound-wound direct-current balancer sets, a switchboard containing the automatic control and switching devices, and a pilot panel. The machines, Fig. 1, and switchboard, Fig. 2, are installed in a room in the eighteenth story of the building, while the pilot panel containing the remote-control master switches is in the basement. Each balancer set consists of four separate units, having their armatures directly connected mechanically and electrically connected in series across the 240-volt direct-current supply bus. Two armatures are mounted on the same shaft, connected by a flexible coupling to the shaft carrying the other two. By removing the brush-holders and the upper halves of the field-magnet frames and withdrawing the pins from the coupling, a pair of armatures can be removed and replaced without disturbing the rest of the set.

Each of the four units comprising one balancer set is rated at 60 volts, 416 amperes. Under normal conditions two of the sets run continuously to carry the load, the third set being held in reserve to take the place of either of the operating units in case it should be shut down by the operation of its automatic protective equipment or for any other cause.

In the multi-voltage system power is supplied to the elevators from five main buses (see Fig. 3) which provide four accelerating steps for the elevator motors of 60 volts per step. Voltages for the four-step buses are individually supplied by the four units of the balancer sets, acting cumulatively in turn. Considering the acceleration of one elevator motor only, on the first

step, say the motor is connected from the + to the *A* bus, then one unit of the balancer is supplying 60 volts to the multi-voltage bus, and the other three are motoring. On the second step the elevator motor would be connected from the + to the *B* bus. Under this condition two units are in series generating 120 volts, and two are motoring. On the third step three units in series are generating 180 volts and one is running as a motor. When full elevator speed is reached, the elevator motor is supplied directly by the 240-volt bus. When this condition obtains, the balancers float across the line idle unless the current becomes unbalanced for any cause, in which case the set will make up the discrepancy. The elevator motors are evenly divided between the buses so that one-half of them are connected to start from each side of the line. As will appear from the following, this arrangement takes care of the a fraction of the total current of the elevators, while on the partial voltage steps must be handled by the balancers.

Some interesting features have been incorporated in the design and connection of the balancers, which will be considered before taking up the operation of the automatic equipment. As stated, the four units are compound-wound, the shunt fields being connected in series across the 240-volt buses, as indicated in Fig. 3. These fields are wound for approximately 60 volts per unit and are all excited by the same current, regardless of the voltage regulation of their various armatures. The series fields incorporate an unusual method in design and connection, calculated to reduce the possibilities of unbalanced loading on the balancer units operating in parallel, either as motors or generators. The series-field windings of each unit are divided into two

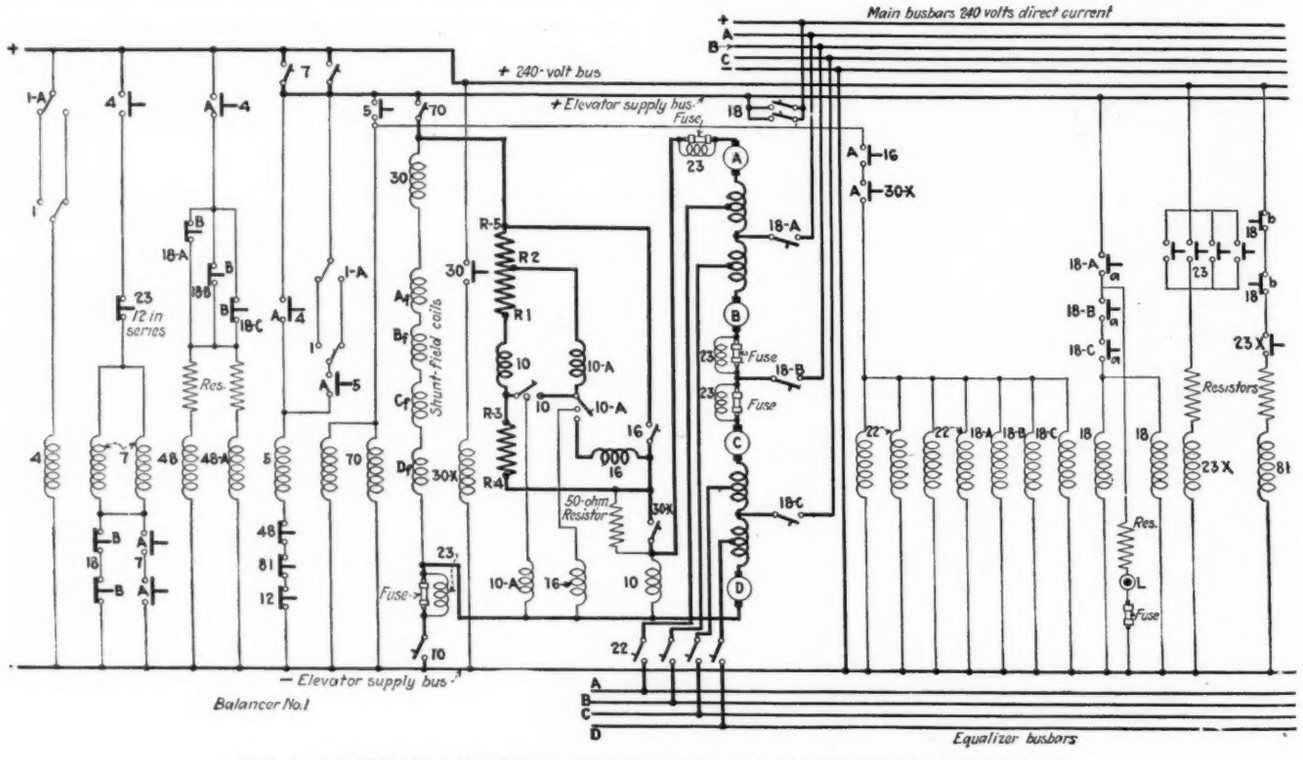


FIG. 3—SCHEMATIC DIAGRAM OF THE CONTROL FOR ONE BALANCER SET

service while imposing the least practicable loads on the balancers.

A study of the principal elements of the multi-voltage system arranged thus shows that the balancers are not even required to handle all the energy used or regenerated by the various elevators in accelerating or retarding, or running at half speed. As the simplest example of this principle, while No. 1 elevator is connected during its starting sequence from the positive bus to the middle-step bus, and No. 2 elevator is connected during its sequence from the negative bus to the middle-step bus, the motors of these two elevators are in series, directly. If their current requirements are equal, none of this current will pass through the balancers, while if the current requirements are unequal, only the difference will be handled by the balancers. Similar conditions, elaborated for the entire number of elevators, and considering various momentary relations of the elevators to the multi-voltage system, show a vastly more complex but similar relation whereby only sections in series, one wound as a magnetizing or cumulative field and the other as a bucking or differential field. These field windings are so connected to the equalizer bus that the cumulative windings are equalized, but the differential ones are not. Consequently, in the case of two units operating in parallel, if one tends to "hog the load," while the cumulative fields of both remain practically equal, the differential field of the heavily loaded unit is increased, lowering its total field strength, while that of the other unit is decreased, raising its total field strength. This action minimizes any unequal division of load tending to arise from any cause.

The three balancer sets and their control equipment are connected to the multi-voltage buses similar to the one shown by the schematic diagram, Fig. 3. The control for No. 3 balancer, the reserve unit, is slightly different from that for Nos. 1 and 2, because its service requirements are more exacting. Roughly, the results accomplished by the automatic control equipment are as follows: Balancers No. 1 and No. 2 are normally

started either by the master switch in the basement or that on the switchboard in the balancer room. In case either of them fails to start and go into service automatically, and normally, on the actuation of its master element, No. 3, the reserve balancer, will automatically start and go into service to take the place of the machine that has failed. If either No. 1 or No. 2 balancer, while running, is shut down and cleared from the circuit by the protective equipment, this will also cause No. 3 to start and go into service automatically. When the machine that failed is in condition to restart, which can be only after the manual resetting of certain relays, it can be started and operating before No. 3 has cleared. Thus the automatic switching equipment insures an adequate supply of power on the elevator buses at all times. The automatic sequence for starting any one of the balancers and putting it on the line under normal conditions is as follows:

At the starting position the negative of the 240-volt power circuit energizes the negative elevator supply bus, but the positive one is open at contactor 7. The starting protective relays 48, lockout voltage relays 81, overload relays 23, and the speed-limit switch 12 are all closed. The original starting impulse is given by throwing either the master switch 1 in the balancer room, or 1*A* on the pilot board in the basement. These elements are connected after the manner of three-way switches, so that the machines may be started or stopped by either of them. In the "off" position both switches may be closed, but in such a position that no circuit is completed that will start the equipment. (Fig. 3 is a straight-line diagram, therefore all the elements of any particular contactor or relay will not be found together; that is, the coil may be found in one circuit and the switch element in another.)

Explanation of Controller's Operation

When the master element is thrown to start the set, it energizes control contactor 4, which closes, completing three circuits simultaneously. The first is from the positive of the 240-volt supply, through the left-hand *A* switch of contactor 4, through the *B* switches on contactors 18*A*, 18*B* and 18*C* to the coils of the starting protective relay 48 and its auxiliary 48*A*. These relays, being energized, start to open against a time delay, which holds them closed long enough to permit the completion of the rest of the sequence. The second circuit is completed through contact 4, the lower contacts of relays 23, and the left-hand *B* switches of contactor 18, and energizes the coils of contactor 7, which closes, energizing the positive station bus. The third circuit is completed through the right-hand *A* switch of 4, through the contacts of relays 48 and 81, and speed-limit switch 12, to the coils of control current contactor 5, which closes. Contactor 5 is locked closed by a circuit through its *A* switch, the pilot panel master switch 1*A* and No. 1 master switch.

When contactor 5 closes, it completes the circuit from the positive-supply bus to energize the coils of machine-isolating contactors 70, which close, connecting the four shunt fields of the balancer set across the 240-volt line. These contactors also complete the armature circuit of the balancer through a 50-ohm resistance which is connected across the contacts of auxiliary field relay contactor 30*X*. The 50-ohm resistor is inserted in the circuit at this point to allow the shunt field to build up before any appreciable amount of current is admitted to the armature circuit. It thus prevents the balancer from starting until the shunt field is up to full normal value and, besides, serves as a discharge resistor for that field.

When the shunt field has built up to a predetermined value, the coil of field relay 30 is energized sufficiently to close the relay, which, in closing, energizes the coils of 30*X*. This latter, in closing, short-circuits the 50-ohm resistor, leaving the four armatures in series with the 240-volt supply through the regular starting resistor. The starting resistor, as the sequence progresses, is cut out of the circuit in three steps: The first by the closing of contactor 10, a series contactor that closes when the starting current has fallen to a predetermined value; the second by the closing of contactor 10*A*, the series coil of which is energized by the closing of contactor 10; and the third by the closing of running contactor 16, the voltage coil of which is energized by the closing of contactor 10*A*. When 16 has closed, the four balancer units are in series across the 240-volt bus.

Connecting the Balancer to the Positive Bus

When the running contactor 16 closes, a circuit through its *A* switch, the contacts of 5, and an *A* switch on 30*X* closes equalizer contactors 22, one of which is connected between the series field of each unit and its equalizer bus. Another circuit is completed which energizes the intermediate line contactors 18*A*, 18*B* and 18*C*. These contactors in closing connect the common leads between the four units of the balancer sets to the intermediate or step buses of the multi-voltage supply. When the intermediate contactors close, they break the circuit to the coils of relays 48 and 48*A* before their time delay setting has permitted them to close. The closing of 18*A*, 18*B* and 18*C* also energizes the coils of the line contactor 18, which closes and connects the 240-volt supply to the outgoing positive bus. As a result of the closing of 18, all the multi-voltage buses, positive, negative, *A*, *B* and C, are energized. The closing of 18 also lights an indicating lamp *L* on the pilot panel in the basement as a signal that the intermediate line contactors 18*A*, 18*B* and 18*C* have closed and that the balancer is on the line and operating.

Design of Protective Devices

Every effort has been made, in designing the protective equipment to guard thoroughly both the machines themselves from troubles and delays due to abnormal conditions. The conditions from which the balancers are protected are five: Over-speed, overload, failure of the shunt field, hot bearings, and failure to start within the predetermined time limit.

In the design of the control system it was necessary to devise a scheme by which a disabled balancer unit could be cut out automatically and the reserve balancer placed in service automatically, without causing any more than a brief interruption to the elevators. Consider the hypothetical case where only one balancer is in operation and develops a short-circuit. Consider further that it is cleared off in the ordinary manner by opening its circuits to the control buses. An elevator connected at the moment to an intermediate, or step bus, and overbalanced so that it was regenerating, would continue to run and would overspeed. Passengers would, of course, be fully protected by the overspeed safety devices forming part of the car equipment, but the unnecessary operation of this equipment is undesirable for various reasons.

As actually designed, therefore, the system provides

that if a balancer becomes disabled it is left connected to the elevator buses, but the incoming power circuit is disconnected. The circuits are thus maintained whereby the various elevator motors can feed into each other, and into the balancers, thus preventing the speeds of individual elevators from becoming excessive. Because of the mechanical and electrical losses the system comprised by the elevator motors and the balancers will "run down"; that is, the voltage will decrease to a value at which the elevator brakes will be applied. As the voltage of the balancer substation decreases still further, an automatic sequence is established which cuts off the disabled balancer permanently and starts the station up again with the reserve balancer taking the place of the disabled one.

How Protection Is Provided

The unusual requirements outlined in the foregoing paragraph are met by the following sequence on the part of the automatic equipment: In case of an extreme overload on any armature an open-link fuse directly in series with that armature will blow, shunting the entire overload current through the low-resistance coils of overload relay 23. The capacity of the fuse is sufficient to hold against all loads except sustained short-circuits. Relay 23 opens its lower contacts (shown in the second circuit on the left of the diagram), opening the coil circuit of contactor 7, which opens and disconnects the entire balancer substation from the supply. This allows the voltage of the whole balancer system to die down, and at about 80 per cent voltage the control of each elevator will clear itself and set the brake on the elevator. When the voltage has dropped to about 50 per cent of normal, all the automatic switching devices, with the exception of 4 will have opened, relay 23 will reclose, and the balancer that was not in trouble will restart in the regular sequence. The set that caused the shutdown will be locked out and set 3 started in its place.

In case of field failure the field relay 30 will open, opening 30*X* and disconnecting the set from the main positive bus. At the same time it opens 18*A*, 18*B* and 18*C*, which close the circuit to start up 3. Hot bearings cause a bearing temperature relay to close and ring an annunciator bell in the basement, which warns the operator to shut down the set in trouble and start up No. 3.

Failure to start is prevented from causing any damage to the machines by the fact that relay 48, which is actuated by the closing of contactor 4, will, if its circuit is not opened by the closing of contactors 18*A*, 18*B* and 18*C*, open and break the circuit of master-control contactor 5, shutting the set down. Since 48 is hand reset, the balancer cannot restart until an inspection is made. Balancer 3 is, in this case, started by the closing of relay 48*A* in the circuit of the set that is closed down.

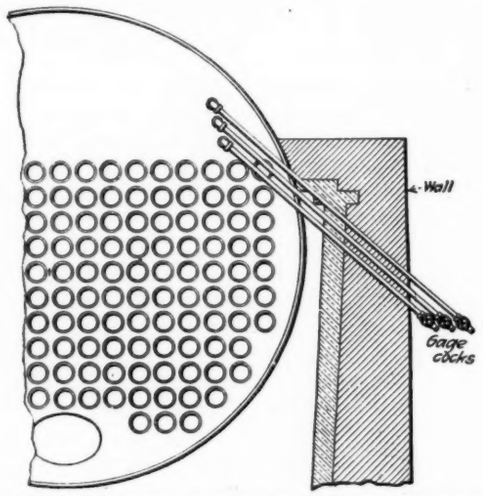
The power plants of Latin America are in need of expansion, and only the war and post-war confusion has delayed the purchases. As rapidly as possible the power stations are being enlarged to meet the existing demand resulting from electrical development in these countries. An interesting example, which is typical of many other installations, is that of the power house of the Hispano-Americano Company in Buenos Aires, where two 7,500-kw. steam turbines are being replaced with three 25,000-kw. steam turbines.

Boiler Inspection—V

By James F. Hobart

THIS article, the fifth of the series, points out the different parts and fittings that should be given special attention when inspecting from the front head.

HAVING finished the inspection at the rear end of the boiler, the inspector should turn his attention to the front head. A box or bench should be placed so that access is easy to the front of the boiler without the labor of climbing up and down upon the partly opened ashpit doors. A carpenter's trestle is a convenient article for this part of the inspection. If placed close, the inspector can stand directly upon it just outside the opened doors and look over everything neces-



A DANGEROUS METHOD OF CONNECTING GAGE COCKS, FOUND BY THE INSPECTOR

sary. Attention should be given to the hand or manhole in the lower portion of the boiler and the condition of the shell and reinforcing rings carefully noted, also if any corrosion is taking place at this point.

Gage Cocks and Water-Line Glass

The position of the gage cocks should be closely noted; also, it should be seen that the pipes leading to the three cocks enter the boiler at their proper places. The lower one should be far enough above the top row of tubes to insure water safety even when the water level is just below the opening. The inspector should also note if the upper gage cock is not connected to the head too high up, so that when the boiler carries "three gages of water," the shell will be almost full.

Another point must be closely observed—that the pipes from boiler openings to gage cocks lead thereto in a level position. Fig. 1 shows the arrangement of gage cocks in a boiler once inspected by the writer. This was put in by the owner of the boiler, who did his own pipefitting.

In explanation he said that if the pipes ran out level from the connections to the boiler, the cocks were too high to be reached without climbing a short ladder. "By pitching the pipes," he said, "the cocks were brought down within reach."

A slight study of this arrangement reveals a dangerous condition. If opened at intervals of a few minutes, the cocks as shown would indicate the presence of water or steam as the case may be; but if opened at intervals

of one hour or longer, they might show water when there was none in the boiler at that level.

This is because the upper opening would almost always be into the steam space of the boiler. But owing to the pipe's leading downward and being closed at its lower end by the gage cock, it fills with condensation, so that when the cock is momentarily opened, water is discharged. The same is true of the other two pipes, and in order to obtain a correct reading they must be kept open for some time, until the water in the pipes can be blown out. The inspector should condemn connections of this kind and order the pipes changed so that they run straight and level from the openings to the boiler. The method of connecting gage cocks directly to the boiler is now seldom used. It is replaced by the water column, which is much better and safer.

Water Column and Connections

It is best that the gage cocks be attached, together with the water-gage glass, to a water column of ample dimensions and connected with the boiler both above and below the water line, with 1½-in. pipe. The connections should never be made with less than 1¼-in. pipe. The inspector should make sure that both connections, particularly the upper one, run level from the opening into the boiler, the necessary height between the horizontal pipe and the column being obtained by vertical pipes immediately above and below the water column. There must be no air or water traps in either connection.

Having looked over these connections and made sure that they conform (or otherwise) to the requirements mentioned, the inspector should procure a level and the necessary straight-edge and proceed to level from the top of the upper row of tubes in the boiler, to the water column, and thereby determine if the water column has been properly set.

While he is going over the front head, he should note if the feed pipe enters through the front head, close to the shell and just above the upper row of tubes. Should it enter the boiler at any other point, he must examine closely to see that the water is not spilled where it may prove harmful to the shell plates. More about feedwater pipe arrangement will come up when the inspector gets inside of the boiler.

What To Look for on Front Head

The inspector should examine the front head for leakage and corrosion, in much the same manner as he did the back head. Should the boiler be of the portable or semi-portable type, there may be trouble at the front head from wasting, corrosion, tube leakage, etc. Such is likely to be the case when the boiler is used intermittently, for during the idle periods water finds its way down the smokestack, upon the front head and even into the tubes. All tube-sheet troubles may be looked for under such circumstances.

Before passing from the front end of the boiler, the inspector should look closely for the defects mentioned in a previous chapter—flame leakage between front end of boiler and the brickwork, which may cause burning out of the dry-sheet, or if the boiler is of the flush-front type, the inspector will see and report any leakage of gases between the boiler and brickwork, direct from the firebox into the uptake.

The front of the boiler setting will also come in for close scrutiny, and a loose and leaky front, with cracked plates or loosely fitting doors, should receive unfavorable comment in the inspector's report. He will also see if the steam gage is properly located, with the necessary water trap to prevent damage by live steam. On the top of the water column is a good place for connecting the steam gage. While examining this part of the boiler he should also see whether there is adequate connection at the bottom of the water column for the ready and frequent blowing off that is necessary to keep the column and its connections free from mud and sediment.

If the boiler is fitted with a mud drum the inspector should carefully examine it and obtain measurements whereby the strength of the drum may be calculated, the same as for the boiler shell. If any leakage or corrosion exists it should be reported with the necessary recommendations.

The inspector should pay strict attention to the manner in which the top of the boiler has been covered. He will frequently find a brick arch over the boiler which will prevent him from getting at any portion of the shell. This has been the writer's personal experience, and in more than one instance he has had to remove the brick covering on such portions of the shell as he thought necessary to inspect.

Coverings Should Be Kept Dry

When water pipes pass above a boiler, the inspector should note the fact and see that no water from leakage or condensation falls upon the boiler covering. Instances have been known where the constant dropping of water from overhead pipes, upon a brick-covered boiler, has caused corrosion of the shell to the extent that a blow from the inspector's hammer drove a hole through it.

The inspector should also notice if any heavy shafting runs above, or close enough to the boiler to cause injury to the shell or piping should the shafting be torn down by accident. Also he should see if any large pulleys and heavy belts are so running that in case of breakage they could possibly injure the boiler by striking against the shell, demolishing the brickwork and possibly moving the boiler from its proper place.

If there is any woodwork in close proximity to the boiler setting, the inspector should report it, as many fires have been caused by woodwork placed too close to the boiler. In some factories where the writer has made inspections, the entire top of the boiler setting was used as a dry-house and several tons of stock were piled thereon. In addition to the fire risk the extra weight of the material placed on the boiler is objectionable and the inspector should strongly protest such practice.

Nothing about the safety valve should escape the attention of the inspector. He should note its kind and condition and determine if it is working freely, also whether there is a stop valve between it and the boiler. If one is found he should order it removed.

Close attention should be given by the inspector to the condition of the main steam pipe and to the manner in which it has been erected, also if expansion and contraction can take place without causing undue strain upon the nozzle of the boiler to which the pipe is attached.

The inspector is now ready to go inside of the boiler and determine conditions there, where much inspection work must be done. The steps to be followed in making the internal inspection are described in the next article of this series.

Balancing Machine Utilized in the Field for Quickly Correcting Turbine Operation*

Balancing at 140 R.P.M. on Flexible Mounting Produces Good Operation at 3,600 R.P.M.—Temporary Shaft Coupled to Field Provides Second Journal—Balance Corrections Are Calculated for Convenience in Attaching Weights

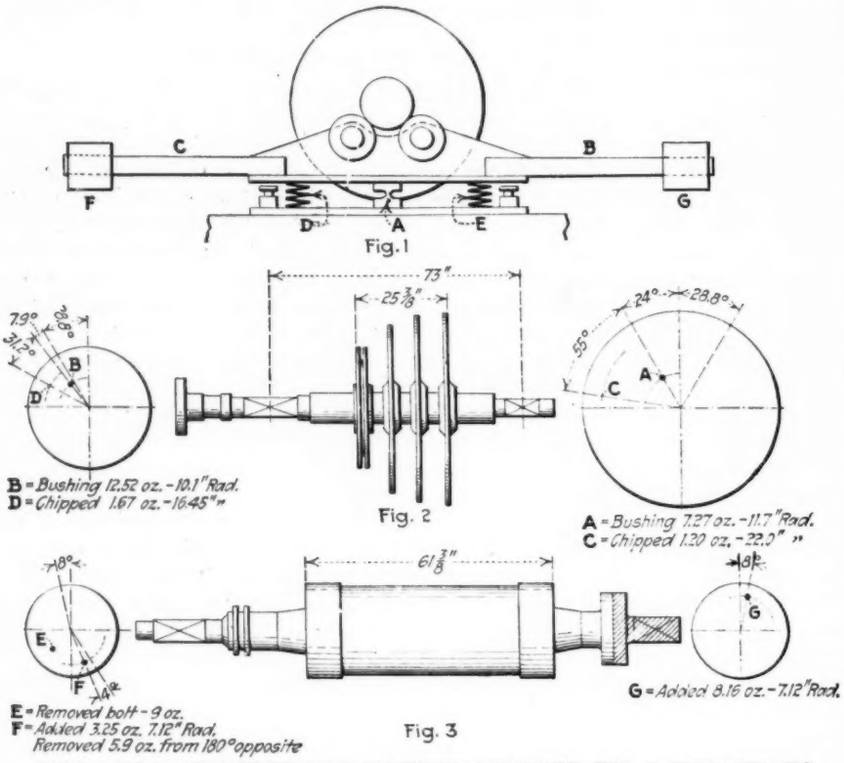
BY H. D. FISHER†

THE Ebensburg Coal Co. was recently confronted with a difficult problem in turbine balancing, and as such situations arise in power plants from time to time, their solution of it may be valuable to others.

The unit is a 2,500-kw. 3,600-r.p.m. impulse-type machine about six years old. Owing to erosion of the buckets, caused by excessive moisture in the steam, it has required frequent reblading, and in addition to this one or two buckets have been lost on two occasions, when the turbine could not be spared long enough to replace the full wheel of buckets. It has therefore required rebalancing so often that nearly all the chipping strips provided for adjusting balance had been removed on former occasions.

After the last reblading it seemed impossible to secure a satisfactory running balance by the usual field method, although the builders and engineers spent over a week at it on two occasions. They seemed to secure satisfactory markings on the shafts, but the shaft surfaces were too rough for accurate indications and the machine was too noisy after adjusting balance to these markings. Furthermore, considerable vibration could be felt on the bearings, especially at the turbine end.

The Vibration Specialty Co., of Philadelphia, which was called upon to inspect the unit, guaranteed to indicate the proper location and amount of the corrections to be applied by means of their portable balancing machinery on a "no cure, no pay" basis, only requiring the assurance that no buckets were missing on any of the wheels and that the shafts were not sprung. This company manufactures and uses the Akimoff machines, the principles of which are herein described.



FIGS. 1 TO 3—THE FLEXIBLY MOUNTED BEARING, FIG. 1, UTILIZED TO BALANCE REVOLVING ELEMENTS OF A TURBINE UNIT

Fig. 1—Vibration of flexibly mounted bearing forces side arms to oscillate. Fig. 2—Weight was added and some metal removed at each end of turbine rotor. Fig. 3—Weight easily added in grooves provided at each end of field.

The rotor, crankshaft or other piece to be balanced is supported by its own journals on two specially designed roller bearings which are slightly self-aligning and rotated at moderate speed. One of these bearings is fixed, but the other, shown diagrammatically in Fig. 1, is supported flexibly on the equivalent of a knife-edge at *A*, directly below the bearing, so that it may rock from side to side with the vibration caused by the unbalance of the piece being tested. The motion of this bearing is restrained by spiral springs *D* and *E*, and its inertia can be changed by means of the weights *F* and *G* on the horizontal lever arms *B* and *C*, so that the period of vibration of the bearing will correspond to some convenient low speed for balancing the rotating element. Then when the piece under test approaches this speed, if it is out of balance, each pull of shaft oscillation tends to build up the oscillation of the bearing with its springs and weights just as though it were a pendulum, and a very slight force due to out-of-balance of the piece acting at the same time interval of swinging, will gradually build up a considerable oscillation of the bearing. By magnifying vibration in this way it is easily recognizable and accurately measurable by a dial indicator under one corner of the bearing, showing the amount of displacement or "throw."

To determine the balance correction necessary, a collar carrying threaded arms with weights on them, itself carefully balanced, is attached to the journal supported by the flexible bearing, and a trial adjustment

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†Mechanical engineer, Ebensburg Coal Co.

made for angle and radius of the weight, based on previous experience. The piece is brought up to the same speed, which before was found to produce the greatest vibration of the bearing, and it is noted whether the reading of the dial gage is increased or diminished. Owing to the rocking motion of the bearing it is possible to mark the high side of the shaft with reasonable accuracy so as to determine the angular position of the adjustment required, and with a little practice the correction necessary can be arrived at within two hours. The piece to be balanced is then turned end for end in the bearings and the same process is gone through with the other end of the shaft, the two corrections obtained giving the amount and location of both static and dynamic unbalance. Knowing the location of the groove where weight is to be inserted or the chipping strip where it is to be removed, the exact position and weight to give a perfect running balance may be calculated with mathematical accuracy.

Driving Motor Placed Vertically Below Field

In cases where the turbine bearing supports are not necessarily removed in dismantling the unit, it is possible to mount the balancing machine bearings on the bearing frame and make the test with very little trouble. Where this is not possible, it is usually advisable to install concrete piers as shown in Fig. 4, as an absolutely solid foundation is essential for accurate work.

On the left-hand pier *A*, Fig. 4, is mounted the fixed bearing *B* and a thrust bearing *C* provided with two ball-bearing universal joints to prevent end play of the rotor. The revolving field, which is here being balanced, is driven by a motor through a countershaft on the floor directly below the rotor, so that the belt pull should have no effect on the horizontal motion of the rocking bearing. The motor used was a 20-hp. machine that happened to be available, and speed regulation was obtained by driving it from a spare exciter unit on which the voltage could be adjusted as required. The power necessary is small, and 5 hp. would probably have been sufficient.

The rocking bearing was supported on the other pedestal *D*, which, to allow for the differing lengths of turbine rotor and revolving field, was provided with two sets of holding-down bolts. As the rotating field had a bearing at only one end it was necessary to provide an accurately made stub shaft, *E* with a flange to fit that of the coupling connecting field to rotor. The rollers on which this bearing runs are seen at *F*, the rocking support of the bearing at *G*, one of the springs at *H*, a jack for locking the bearing when setting up or removing test pieces at *I*, and the arm and weight for adjusting the inertia of the system at *K*.

Inserting Bushings and Chipping Metal Produces Balance

The correction indicated by the displacement of the weight on the revolving clamp is a function not only of the weight and its displacement from the center of the shaft, but also of the distance from the fixed bearing, so that it is a compound moment which can be expressed as so many ounce-inches. The weight must be accordingly proportioned to the distance of the groove or hole to receive it from the shaft axis, as also its distance from the fixed end bearing. Similarly, if it is necessary to insert the weights in holes that are not exactly in the angular plane determined by the balancing clamp, the distribution of the necessary correcting weight can be graphically solved to give the equivalent of the moment desired.

In this case the chipping strip had been removed to such an extent on the high-pressure wheel that it was necessary to insert a weight in one of the pressure balancing holes of the disk; and as this did not come exactly in the plane desired, a further small correction was made by chipping at the rim, and a similar operation was carried out on the low-pressure disk.

On the revolving field it was easier to apply the correction, as a groove is provided with conveniently located screw holes, and the corrections applied to this piece are shown in Fig. 3. Some uncertainty might arise from the stub shaft, but it indicated within 0.0015 of true.

The speed at which the greatest vibration occurred with the adjustments used on these tests was about

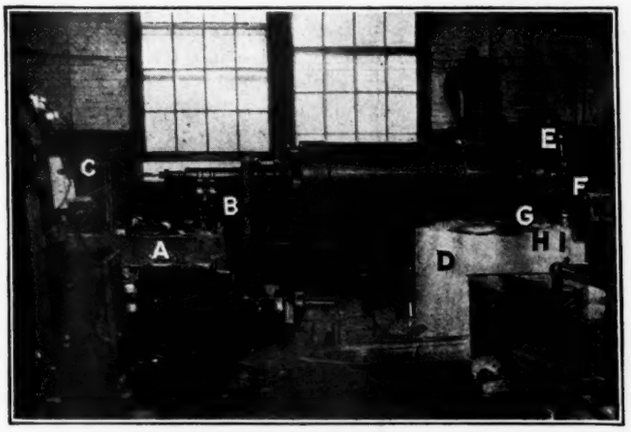


FIG. 4—CONCRETE PIERS INSTALLED FOR BALANCING TURBINE FIELD AND ROTOR

140 r.p.m. At the start the writer was a little sceptical as to whether a balance obtained at such a low speed would hold at speeds of twenty-five times this amount. While cases can be cited in which this may not be true, yet for the usual construction of turbines with the individual wheels balanced separately, the unbalanced differences between the different wheels are too small to produce any appreciable springing of the shaft. According to the theory of elasticity the distortion at a speed of even 140 r.p.m. will be relatively the same as at 3,600 r.p.m. as long as the elastic limit of the material is not exceeded, and if we have sufficiently delicate apparatus to measure it at the lower speed, we can balance just as well as at the higher speed. This balancing method requires that the springing of the shaft under normal conditions shall be practically negligible. It is for this reason that the Vibration Specialty Company is so insistent that no buckets be missing.

The work of dismantling the turbine was started Saturday afternoon, Dec. 23, 1922, and in spite of almost a day's lost time in remaking a bushing for balancing the turbine rotor, the unit was reassembled and put in service Wednesday morning, Dec. 27. So by taking advantage of the slack period around Christmas, it was possible to put this unit, for which no adequate spare capacity is available, in first class condition. The turbine has run continuously since then except for a few hours' shutdown to replace worn parts not on hand at the time it was balanced, and it makes exceptionally little noise and shows less vibration than many new units.

New Leadizing Process for Piping and Steel Plates

By C. C. Lance*

Until recently no practical protective coating has been available for steel plates and piping subject to rapid corrosion. The maintenance cost of the unprotected pipe lines has been a serious item of expense to railroads and other large users of pipe. The galvanizing process affords no protection against acid fumes and the nature of the coating, which is only a surface deposit, makes it easily damaged, so that the coating will flake off when the pipe is struck or bent.

So much trouble was experienced by the Santa Fe Railway from the corrosion and pitting of locomotive boiler tubes, due to bad water conditions, that experiments were started to develop a remedy. Other sources of trouble were the piping and steelwork generally in railroad shops, roundhouses and other buildings where the gas from the locomotives penetrated. This gas, usually containing considerable sulphur, lodges under the roof and, combining with the moisture from steam vapor, forms a mixture containing sulphurous acid, which drips on piping and causes rapid corrosion. Steam lines properly insulated are not protected from injury, as the gas penetrates the smallest crevices. Outside of buildings around the yards, pipes buried in the ground or laid beside tracks are damaged by the chemical action of the cinders prevailing in these places. Some of the pipe lines corrode so rapidly as to require renewal within three years. These renewals are expensive and inconvenient owing to the 24-hour service usually existing. A wide variety of services are affected. For example, corrosion takes place in pipe lines for the conveyance of steam, compressed air and cold water, in boiler-washing and heating mains and returns, acetylene and oxygen lines, boiler-test lines and piping for special purposes as well as electric conduits.

It is not only in railway work, however, that rapid corrosion is prevalent. The average power plant is not free from troubles of this sort. The piping may be attacked externally or the chemicals found in some waters may corrode the interior surface. There are many places in the plant where protected steel piping at a cost on a par with wrought-iron piping would be highly desirable.

In the Santa Fe experiments lead seemed to be the best metal for the purpose on account of its resistance to corrosion and its long life. It was thought that, by combining lead with steel, or, rather, by coating steel with lead, a satisfactory protection might be evolved. This method was tried out with success, and an examination of some of the lead-coated pipes installed at Topeka in 1917 failed to show any depreciation, although in one instance the pipe examined had been buried in cinders for several years. Other piping was subjected to constant moisture in a drainage manhole with practically no sign of deterioration. The original lead coating remained intact, the only indication of service being a slight blackening of the surface.

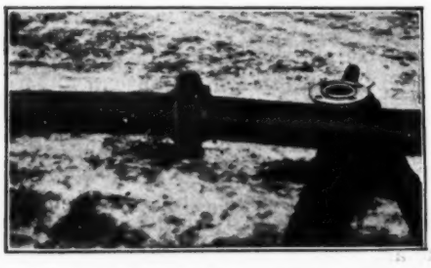
The first step in the leadizing process is to remove the grease and oil from the material to be treated by immersion in a hot lye bath. After its removal it is washed with water and placed in a bath containing a 17 per cent solution of hot sulphuric acid. After the material is in the acid, about one pound of Chile saltpeter is added for each 40 sq.ft. of surface to be cleaned. The saltpeter causes an eruptive action which thoroughly scours off rust and mill scale from the surface of the steel, leaving a clean surface.

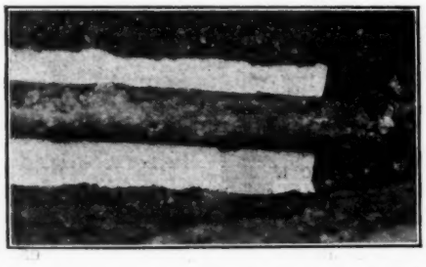
Following its removal from the sulphuric acid, the material is washed off with water and placed in a bath of hot acetate of lead. The acetic acid in the bath having greater affinity for steel than for lead, picks up steel and deposits lead, and at the end of twenty minutes, leaves a thin impenetrable homogeneous coating over the entire surface inside and out. As this coating insulates the steel, and longer immersion does not increase the thickness of the coating to a point suitable for general commercial uses, the material is removed and placed in a second bath containing acetate of lead and iron sulphate.

Use is then made of a regular plating generator, the material to be coated being connected to one pole and the lead anodes to the other. After an hour and a half in this bath, using a current of 1 ampere per square foot of surface, a coating of suitable thickness for all practical uses is obtained. In the same length of time, however, a coating of greater thickness might be obtained by increasing the current density. After removal from this final bath the coated material is washed off and painted, partly as it is a convenient time to do it and also to cover up the red streaks left on the surface of the coating by the iron sulphate in the bath. The paint adheres to the treated surface, as it has a natural affinity for the lead coating.

Examination of the treated surface shows an even coating of lead which is malleable and ductile and not subject to damage from bending or distortion, the lead, in fact, forming a component part of the material. As previously stated, the lead treatment protects against the corrosive action of sulphuric acid, but does not give

*Engineer, National Boiler Washing Co., Chicago.





FIGS. 1 TO 3—VIEWS OF LEADIZED PIPES BEFORE AND AFTER USE UNDER VARIOUS CONDITIONS

Fig. 1—View of leadized pipe at Barrington shop. Fig. 2—Leadized iron pipe installed in 1917; notice moist earth sticking to it; pipe in excellent condition; no perceptible deterioration. Fig. 3—Main acetylene line installed in 1917; slimy portion has been scraped clean; no changes have been made in line; although bell and water seal of galvanized-iron acetylene generator near-by have been renewed three times during the same period on account of the rapid corrosion.

entire protection against the action of alkaline solutions found in the water used by railroads in some parts of the country.

In the case of steel tanks for boiler-washing systems, the plates are first cut to size and punched, then leadized and bent to the proper radius before erecting. Lead-treated rivets driven cold are used, the formed heads being exposed to the water, but even the upset ends of the rivets show excellent penetration of lead.

Of the pipe lines used for the various services previously mentioned, some have been made up flanged and some screwed, but all have been fabricated at the Barrington shops, either cut to length and threaded before treating in the case of screwed lines, or made up to the required measurements for flanged lines. The leadizing treatment protects both flanged and screwed piping with equal satisfaction, making a particularly good coating for the threads, as it covers them as evenly as the smooth surface of the piping.

In ordinary piping the first signs of damage from corrosion are noticed at the threaded ends where the flanges or couplings are screwed on. This portion of

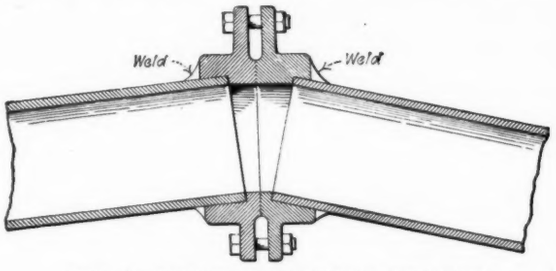


FIG. 4—DETAIL OF SPECIAL WELDED DROP-FORGED FLANGE

the pipe is thinner, and as the outer surface has been removed when cutting the threads, the interior fibers are exposed and are more readily attacked by the action of the gases, so that the threaded portion may be eaten away while the remainder of the pipe may not be much affected. Galvanizing or painting steel pipe does not protect it against this action, so that it is often the case that such piping must be replaced as frequently as ordinary piping.

To overcome this trouble prior to the development of the leadizing process, a new type of flange connection for piping was designed, heavy drop-forged steel flanges without threads being used. This is shown in Fig. 4. The flange is shrunk on and finally welded to the pipe, and outlets are also welded to the pipe. In this way much of the work formerly done in the field is now transferred to the shops. Full measurements are taken on a job and straight piping is employed throughout, any variation from a straight line being secured at the flange. The straight blank pipes are cut to the proper length and the extra-heavy drop-forged steel flanges are bored out to the proper angle in a special adjustable jig. These flanges are heated and shrunk on the pipe and permanently welded in place. During the various operations gages set to the proper angle are used to check the accuracy of the work, and before the finished job is turned out the faces of the flanges are ground off smooth in a grinding machine having an adjustable "V" block bed to give the smooth surface for the gaskets necessary to insure against leakage. As each installation is fabricated complete in the shop, the time required for installation is greatly reduced.

The Accuracy of the Indicator

That the indicator, when properly connected and handled, gives an accurate picture of the pressure conditions within the slow-speed steam-engine cylinder is universally admitted. When high speeds are employed, the action of the indicator, by reason of the inertia of its many parts, is not so accurate, although optical instruments have been used at speeds as high as 1,000 r.p.m. In the case of internal-combustion engines a general feeling exists that results obtained by any indicator are inaccurate. It is, of course, admitted that the heavy springs required by piston indicators when used with high pressures, lead to distortions in the diagram, but optical instruments eliminate this objection.

Apparently the vital criticism is that the gas within the cylinder of an internal-combustion engine is not a homogeneous mass. Along the cylinder walls the gas is comparatively cold and acts as a blanket to prevent heat being lost by the hot mass of gas in the center. In addition combustion does not occur instantaneously throughout the entire mass, but burns in spots. As a result the pressures in the cylinder are far from uniform, and some claim that this prevents the indicator from giving a true picture of the cylinder events.

It should be remembered that while the temperature at one point in the cylinder may be much higher than at another point, the average of the several values gives a temperature whose value is that which would be possessed by the gas if it were homogeneous. The velocity of the pressure waves is so high that equilibrium is almost instantaneously established, giving a pressure corresponding to the average temperature of the gases. The indicator registers this average pressure and the indicator diagram may be used with confidence in its truthfulness as to pressure-volume conditions, although, of course, it cannot show instantaneous local pressures.

A recent issue of the "Chase Diamond" tells of the heating system installed in the Chase Metal Works when the plant was built in 1910. "Since that time," the article goes on to say, "many companies have installed their heating systems following our engineer's plan, but the credit for working out the solution goes to John Williams, our chief engineer. How is it done? It is done by connecting over 78 miles of pipe directly to the condensers in our power house and by pumping hot water through the mill, returning it back to the condenser, again reheating it on in this endless chain, through the mill and back. In all over 36 acres of buildings are heated, with a partial vacuum on turbines and engines."

It is often supposed that steam-turbine blades are designed with their entering channels parallel to the paths of the steam projected from the stationary nozzles. A construction of this kind would receive steam without undue shock if the wheel were standing still, but if the wheel were revolving, the turbine blade would tend to deflect the steam and make eddies in the entering path. In order to receive the steam without undue shock or eddies, the angle of the entering blade passage is changed by swinging it a certain amount in the direction of rotation of the wheel, which depends on the speed of the blade and that of the steam received from the nozzle.

Surface Condenser Performance

Relation of Surface, Heat Transfer and Quantity of Water Pumped—Effect of Air Leakage and Cost of Air Removal—Rotative Dry Vacuum Pump Favored —Variable vs. Constant-Speed Auxiliary Drive

By JOHN M. DRABELLE
Mechanical and Electrical Engineer, Iowa Railway and Light Company

SOME engineers have had the impression that high vacuum could be secured only at the expense of excessive investment or at the expenditure of excessive amounts of power for the operation of circulating and vacuum pumps. The performance of a condenser in respect to low absolute pressure and the degree to which these pressures follow the cooling-water cycle of yearly temperatures, are determined by the rate of heat transfer and a second factor, over which the manufacturer has no control; namely, air leakage. In many central stations today this latter factor is given little thought and attention.

Surface, heat transfer and quantity of water are three variables in condenser layout. A small amount of surface may be used and by increasing the water velocities and the quantity of circulating water, high heat transfers may be obtained, giving apparently a unit cheap in first cost, but those who have power plants with such a layout know that with the slightest fouling or plugging of tubes a loss in vacuum shows up quickly and that such a unit requires an excessive amount of power to operate, with its attendant high station use loss.

Conservative practice seems to limit the heat transfer to 350 to 400 B.t.u., although heat transfers of 450 to 500 B.t.u. are not unusual and transfers of 600 to 700 B.t.u. have been obtained on test, but such rates are too high to stand up under the stress of service 24 hours a day and 365 days a year. Apparatus purchased with the surface figured on these higher rates of transfer, provides nothing for emergencies.

Effect of Air Leakage

Air leakage has a direct bearing on condenser performance as the quantity of air in the condenser determines the amount of power required for its removal, and by blanketing the tubes the air causes poor heat transfer. The remedy, of course, is to stop leakage at its source. This requires the most painstaking care in the installation of the apparatus to get everything tight. As a final precaution after the unit has been placed in service, it is good practice to paint all parts of the equipment under vacuum with several coats of asphaltum paint, beginning with a water-thin mixture that will flow into every pore and crevice and gradually increasing the thickness of the paint until the fifth or last coat has been applied. The condenser and piping may be considered tight when the mercury column, with the machine under load and the air pump shut off, will drop but one inch in an hour, and with care this is obtainable.

In an effort to reduce the power requirements for air removal there has been a tendency of late to go back to the use of the rotative dry vacuum pump, as with this type of pump the power required and the rotative speed are in proportion to the amount of air removed. If the air leakage is small, say that it does not exceed 5 cu.ft. per min., such a pump, running at the proper speed, allows the power to be reduced to a minimum. In this connection it is to be hoped that there will be on the market in the near future a reliable and simple air-measuring device for rotative dry vacuum pumps, similar to that already developed for certain forms of hydraulic pumps, so that the operator can have exact knowledge at all times of the amount of air being removed and prompt knowledge of any air leak.

On a test of our 18,000-sq.ft. condenser made last year, some interesting data were secured. The air pump was of the Worthington, two-stage "feather" valve type, motor-driven, so that the power required for its operation could be determined accurately. No special grooming or touching up of any kind was given the condensing equipment. The results in Table I show the economy of the electric drive and of the rotative dry vacuum pump. Based on the water rate of the prime mover the air-removal apparatus required less than 200 lb. of steam per hour for its operation.

TABLE I—RESULTS OF TEST ON MOTOR-DRIVEN VACUUM PUMP

Steam Condensed Lb. per Hr.	Temp. Circ. Water, Deg. F. In.	Out	Abs. Press. At Turbine Blading, In. of Hg.	Power Required, Kw.	Heat Transfer B.t.u. per Sq.Ft.
95,752	35	44.65	0.46	12	306
129,713	36	50.03	0.60	13	335

Cleanliness of the tube surface is of great importance, as fouled and dirty surfaces, both internal and external, reduce the heat transfer and the vacuum at a rapid rate. Algæ in the summer time, as well as mud and slimes generally, give rise to these troubles, which may be alleviated to a great extent by making use of the new method of cleaning condensers while in operation, daily or as often as necessary, with a high-pressure water jet.

Dirt Film on Tubes Reduces Heat Transfer

Carried over with the steam there is also a certain amount of dirt which eventually lodges on the condenser tubes, forming a thin but nevertheless non-conducting film. This film reduces the heat transfer and causes a drop in vacuum. To eliminate losses of this nature, the tube surface should be cleaned with a high-pressure water jet, and if the deposit is of an oily nature, it may be desirable to fill the shell with water into which some cleaning compound has been introduced, and then heat and circulate the water by means of a steam jet.

In any station except the large base-load plant, the load is subject to a cycle of light and heavy periods during the twenty-four hours of the day. It is obvious that the amount of circulating water required over the peak of the load, when the maximum quantity of steam is delivered to the condenser, is greater than at times of light load; also that the quantity of water required

varies with the seasonal change in the temperature of the supply. To take care of these varying requirements, two general schemes are employed: The use of two circulating pumps driven by constant-speed motors or of a single pump driven by a variable-speed motor, usually of the wound-rotor type with external resistance in the rotor to effect the change in speed. At first glance the variable-speed electric drive would seem to be open to the objection of heavy resistance losses at low speed, but a glance at the speed-torque characteristic curve of a centrifugal pump will show that as the speed is reduced the power requirements fall off rapidly, so that the saving in power considerably overbalances the resistance loss. In the course of a year the power saved over the constant-speed drive represents a considerable sum of money.

Table II compares the power requirements of the auxiliaries of an 18,000-sq.ft. condenser with constant- and variable-speed drive. These data were taken from an installation made by the writer, which is in every-day service. Based on 11½ months of turbine availability and current at 1c. per kw.-hr., the annual saving for the variable-speed drive for this size of unit exceeds $3,200. With reduced speed during part of the operating day, other savings accrue which are difficult to valuate but nevertheless have a bearing on annual costs, such as less wear and tear and lower maintenance.

TABLE II—CONSTANT-SPEED VS. VARIABLE-SPEED CONDENSER AUXILIARY DRIVE

	Constant Speed	Variable Speed	Saving Due Var. Sp
Circulating pump, kw.-hr. per month	70,560	46,169	24,391
Air pump, kw.-hr. per month	14,112	10,587	3,525
Total monthly saving, kw.-hr.	.....	.....	27,916

The requirements of a well-laid-out condenser installation are:

1. Conservative balance between cooling surface and investment.
2. Rational value of heat transfer.
3. Proper water velocity, ordinarily 3.5 to 6 ft. per min., depending largely on the characteristics of the circulating water.
4. Proper balance of surface and quantity of water pumped for maximum load conditions.
5. Careful investigation of seasonal temperature cycle of cooling water.
6. Adequate exhaust nozzle and steam distribution.

For best operating results a condenser should be equipped with the necessary thermometer, mercury column and a good mercurial-type barometer. A daily report form for recording hourly the readings of the instruments and also the load on the prime mover is important. There should be a weekly check on air leakage. The tube surface must be kept clean, both inside and out, and if the pumps are equipped with variable-speed drive, pump only enough water to take care of the load.

A turbine shaft cannot be permitted to touch the bearing metal while under load. The shaft speed of 8,000 ft. per min. and pressure of 100 lb. per sq.in., existing in large units, would almost instantly wipe out the babbitt metal and so lower the revolving element that serious trouble would result. To guard against this possible trouble, oil is supplied to the bearings under a pressure of 6 or 8 lb. and carried by the surface friction of the shaft to a pressure sufficient to float the rotor's weight of 15 to 17 tons per bearing.

New Foster Economizer

The higher flue-gas temperature resulting from the operation of power boilers at the present-day high steam pressures and high ratings has renewed interest in economizers as well as other fuel-saving devices.

This has resulted in a new type of economizer, known as the Foster, which differs widely from those now in general use, the main points of difference being in the size of tubes used, the placing of them in a horizontal instead of vertical position, the use of cast-iron gilled rings on the outside of steel tubes, similar in detail to those used on the Foster superheater and the employment of water for cleaning the tubes in place of scrapers or steam blowers, as is the usual practice.

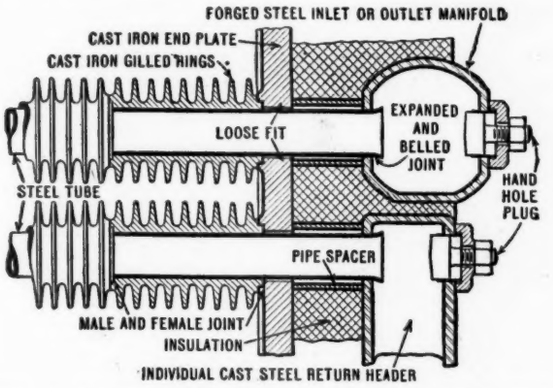


FIG. 1—SHOWS CONSTRUCTION AT MANIFOLD END

The economizer was developed primarily for installation with an individual boiler and with a view to housing the boiler and economizer unit in substantially a single setting. In this way the losses due to infiltration of air in the economizer itself and in the flue between the boiler and economizer could be reduced to a minimum.

The horizontal elements can be arranged for horizontal, upward or downward vertical passes, or with two passes making the gases travel in a U path through the economizer, as may be found necessary to suit conditions or space.

In Fig. 1 is shown the method of connecting the tubes to the headers. Each heating element consists of a 2-in. steel tube on the outside of which is tightly fitted a series of cast-iron gilled rings. The ends of these ring castings are faced with male and female joints to protect the steel tube completely, and only the cast-iron covering is exposed to the flue gases. The resulting extended surface has a decidedly greater outside area per unit of length than a bare tube. The elements are all straight for easy internal cleaning and are expanded into cast-steel return headers which have machined, tapered handholes opposite each tube end. These holes are closed with tapered plugs, copper gasket, yoke and nut. The plugs seat with, and are held in position by, the pressure.

The inlet and outlet connections consist of forged-steel manifolds into which a series of elements is expanded. This arrangement allows the water to circulate through the tubes of each of the rows in series, and the individual return headers connecting each of these tubes permit the free expansion of each element. The counter-current flow principle is used in all designs, and in the larger sizes this permits the economic reduction of the gases from the economizer outlet to a point

below the temperature of the water leaving the economizer. The velocity of the water is sufficient to permit the downward flow without danger of recirculation or water hammer. The elements are supported at their ends by cast-iron tube sheets which are perforated to receive the elements. Each element is supported independently of the others and may be withdrawn without damage or removal of any other element. As all the expanded joints are outside of the gas passage, it is possible to drain the economizer and reroll any joint without shutting down the boiler.

The housing consists of an internal and external casing, and the space between is packed with insulating material. The inside casing is entirely of cast iron with corrugated surfaces to prevent any stratification or laning action of the gases or washing water along the side walls. The plates are flanged and bolted to each other and to the tube sheets. The bottom of the casing consists of cast-iron pans, designed to catch the water used for cleaning the heating surface and conduct it to the drain pipe. The flue from the boiler to the economizer is built of two walls of steel plate, with insulating material between them.

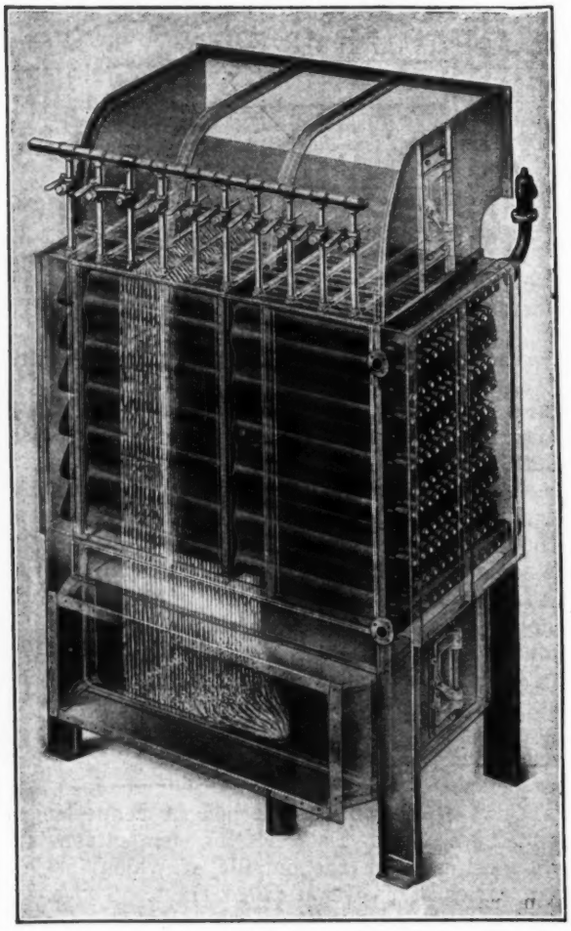


FIG. 2—VIEW OF ECONOMIZER ASSEMBLY AND ACTION OF WASHING WATER

For washing down the external surfaces of the heating elements, permanent spray pipes in a series of groups each controlled by a quick-opening gate valve connected to a common header, are placed above the top row of elements and perpendicular to them. Cross-slots are cut into each spray pipe so that the water falls directly onto each of the elements in the top row. Fig. 2 illustrates an economizer being washed down. The water is admitted into only one group of spray pipes at a time and flows down over the tubes. The corrugations tend to keep the water in the vertical plane in which it is started. This insures a compact body of water covering the tubes and also prevents the water from spreading longitudinally along the tubes.

External corrosion of the heating surface is prevented partly because the gases of combustion come into contact only with cast iron, and mainly because the process of washing the entire economizer chamber admits sufficient water to carry away any sulphurous or sulphuric acids that may have been deposited on the tubes. Internal corrosion, ordinarily caused by non-condensible gases occluded in the water, is avoided, first, by preheating the incoming water in an open heater to a temperature of from 180 to 210 deg. F. and, secondly, by rapid water circulation and positive velocity through all the pressure parts.

In installations where high peak loads are encountered for short periods, a small spillway to bypass a portion of the excess gases during the peak periods is desirable. This spillway may be installed within the economizer casing or built outside of and connected with the economizer flues.

A special design with a small number of tubes and steam soot blowers for cleaning has been developed for small-plant installations. The heating surface of this design is housed in two sets of steel plates with insulating material between, and the elements are supported by cast-iron end plates which are protected by steel doors.

These small economizers may be operated under natural draft and in old plants may frequently be installed with slight expense for alterations in the flues.

The equipment regularly furnished includes the complete heating element, housing, piping and valves for washing, pressure relief valves, and inlet and outlet thermometers and where desired, all correlated equipment.

The economizer is made by the Power Specialty Co., New York.

Turbine-Shaft Packing

The success of the impulse turbine when first introduced, was considered to be due in a large measure to the fact that carbon could be used for rings in sealing the shaft against steam leakage, and such material would operate in contact with the revolving shaft at high speeds without excessive wear.

Metallic fibrous packing also met with success in small turbines at light steam pressures, but was not satisfactory in sealing against pressures in the neighborhood of 20 lb. per sq.in. In medium-sized impulse machines metallic labyrinth packing was successfully used as high-pressure shaft packing and also in the balancing pistons of reaction turbines.

At the present time metallic packing has largely replaced carbon rings in medium and large-sized machines. The largest units have definitely standardized on non-corrosive packing with close axial clearances. For medium-sized turbines the saw tooth labyrinth, in which a radial clearance is used, has been found very adaptable, owing to a soft quality of metal which wears easily when rubbing occurs.

Overhauling a Hotel Refrigerating Plant

BY L. C. MILLER

THE management of a hotel had been having serious trouble with insufficient capacity of the refrigerating plant. While part of this was due to increased business which had added to the load, from all indications the machine had gradually been falling off in capacity for over a year.

The engineer in charge of the plant claimed that the machine was entirely too small for the load. This argument, however, was somewhat discounted by the fact that the owners had another hotel of practically the same size in which the average temperature during the year was considerably higher, and this machine had proved to be of ample capacity for the load. The engineer countered with the statement that there were differences in the operating conditions that accounted for the variation. To this argument the owners had no come-back because they were not familiar with conditions affecting machine operation and they assumed that the engineer was right. Before deciding on investing in a larger machine, they decided, upon second thought, to call in the engineer of the local ice company and get his views on the matter.

The machine had been rated at 20 tons by the manufacturer who had sold it. No one had attempted to determine what the load on the machine was at the time of installation, as at this time it had easily carried the load. The manufacturer's representative had been called in during the summer and asked as to his opinion of the load on the machine. He had agreed that for a hotel of this size a 20-ton machine should be sufficient and suggested that the machine be speeded up, claiming that it was running entirely too slow.

THE ICE-PLANT ENGINEER SUGGESTS OVERHAULING

The ice-plant engineer was non-committal regarding what could be done, but suggested that first the entire plant be given a thorough overhauling. Not being familiar with hotel demands, he stated that he was unable to give any definite answer as to what could be expected from the machine in the way of handling the load.

The machine was of the inclosed, twin-cylinder, safety-head type, belt-driven by a 25-hp. direct-current motor. The motor ran excessively hot whenever the suction pressure went up to 15 lb. The condenser pressure under these conditions would run up to 200 to 210 lb. during the warm-weather period, and, of course, this overloaded the motor.

Part of the load included an ice-cream hardening room, a small ice-cream freezer which required brine at about 5 deg. for good operation, and a fish freezer. The ice-cream hardening room required a temperature of about zero for proper hardening of the cream, and it was desired to keep the fish freezer at the same temperature. Both the fish freezer and ice-cream hardening room were piped for direct expansion, while the brine for the ice-cream freezer was cooled in a small brine tank.

To keep the hardening room and fish freezer down to zero temperature during hot weather, it was necessary to maintain a suction pressure of from 2 to 4 lb. To do this it was necessary to pinch back on the feed to the main brine tank and the ice tank, with the result that the brine-tank temperature sailed up and the ice tank failed to produce the required amount of ice by a large margin.

An extra set of spare suction and discharge valves were ordered, and when these arrived the machine was taken apart and the new valves inserted. The piston rings were found to be badly worn, and a new set was made in a local machine shop and fitted to the pistons. The seat of one of the false heads was found to have a large score mark on it. This was filled up by drilling a hole in the seat, tapping the hole and filling it with a piece of soft iron rod threaded to fit. After filing the plug flush with the rest of the seat, the head was ground in to a tight fit.

CRANKSHAFT BEARINGS WERE IN BAD SHAPE

The crankshaft bearings were in a serious shape and had apparently run excessively hot a number of times. There was no provision made for adjusting the clearance of the pistons to compensate for the bearing wear, and the net result was that the clearance had increased from the normal $\frac{1}{32}$ to about $\frac{1}{4}$ inch. This had a direct effect on the machine capacity, for the re-expansion of the gas in this increased clearance space prevented the suction valve from opening and a fresh supply of gas from being drawn in until the piston had traveled a large proportion of the full stroke.

The ice-plant engineer, after studying the problem suggested that a new 5-ton machine be bought to operate on the ice-cream-hardening room, fish freezer and ice-cream freezer exclusively. This would be operated at about zero back pressure, or two or three pounds above, as might be found necessary, and the big machine would be operated on the rest of the system, at a back pressure of approximately 20 lb. Such an arrangement would practically double the capacity of the large machine, as compared with operation on three to four pound back pressure, while at the same time relieving it of some of the load.

The hotel engineer had one objection to offer to this suggestion—the condenser, which was of double-pipe type and consisted of two stands, 12 pipes high and 20 ft. long, was too small. Normally, a condenser of these dimensions rates from 10 to 12 tons per stand, and sometimes a manufacturer will rate them as high as 15 tons per stand. The ice-plant engineer stood his ground, however, and claimed that the condenser was of ample capacity, and that under maximum conditions he could not see more than about 25 tons load in the entire plant, and this load could be easily taken care of by the condenser at a condensing pressure not to exceed 175 lb. with the water available in the locality, which never went above 65 deg. in the warmest weather.

MANAGEMENT ORDERS A NEW MACHINE

The owners finally decided that this was worth trying, seeing that the only investment required was that for the small compressor and motor alone, so a new machine was ordered and installed in a hurry. It was allowed to take care of all the load it could handle, while the rest was taken care of by buying ice. The big machine was shut down, the bearings renewed and the shaft taken out and turned down in a near-by machine shop. The shaft and bearings were then fitted so that the clearance

between the pistons and the false heads was reduced to less than ½ inch.

When the machine was again started, there was a remarkable increase in capacity. When the pressure went up to 15 lb., however, there was trouble with the motor, particularly as the condenser pressure would run up to about 200 lb. The hotel engineer, of course, told them that this was just what he had expected and that they should add another stand of condensers.

Satisfactory Refrigerating Service

By running the small machine on the ice-cream and fish load and allowing the large machine to work on the brine and ice tanks, there was no trouble in maintaining the desired temperature, and for the first time in several years the chef was satisfied with the refrigerator service. Under these conditions, however, the suction pressure on the large machine would often crawl up to 20 lb. and the condenser pressure in proportion, with an immediate possibility of the motor driving the large machine burning out.

In looking over the installation the ice-plant engineer found that the water supply to the condenser was taken directly from the city service and after passing through the condenser was delivered to an open tank near the ceiling of the boiler room. This tank contained heating coils which heated the water to about 120 deg., after which a centrifugal pump delivered the hot water to the house hot-water heater.

The supply connection to the condenser was 1 in. and the connection from the condenser to the open tank was the same. There were a number of tees and elbows in the lines which added greatly to the friction in the circuit. The total length of the feed line and the line to the open tank was approximately 100 feet.

Assuming a total load on the condenser of 20 tons and two gallons of water per minute per ton, a total of 40 gal. of water would be required per minute for the condenser, and with 60-deg. condensing water the condensing pressure should not be much over 150 lb. To force approximately 20 gal. per min. through a double-pipe condenser having 1¼-in. water pipes and 12 pipes high, requires a pressure of approximately 15 lb. A flow of 40 gal. per min. through a 1-in. pipe 100 ft. long requires approximately 50 lb. pressure; the pressure of elbows and tees would necessitate a considerably higher pressure. The city pressure was approximately 20 lb.; at times it even went down to 10 lbs.

Direct Line from City Water Supply to the Condenser

This trouble was remedied by installing a separate 2-in. line directly from the city water supply to the condenser and by running another line of the same size, directly to the open hot water tank. The length of the water piping was thus reduced to 65 ft. and the friction loss to something like 1 lb. Now, with both machines running at full capacity and 20 lb. pressure on the city main, there was no trouble in maintaining a condenser pressure of 140 lb. Cleaning the condenser by running a scraper through it brought the pressure down another 5 pounds.

While under these conditions there was no trouble with the motor driving the big machine there always remained the possibility of increased condenser pressure and even an increased suction pressure under maximum load conditions. Assuming a maximum suction pressure of 20 lb. and about 200 lb. condensing pressure, the horsepower per ton is approximately 1.75. The dimensions of the cylinders were 9-in. diameter by 9-in. stroke, and at 100 revolutions per minute the machine would rate about 15 tons. At 1.75 hp. per ton approximately 26.5 hp. would be required. If the suction or condensing pressure ran above the figures given, the motor would at once become badly overloaded.

In looking around the plant, the ice-plant engineer found that a 40-hp. motor had been provided for one of the ventilating fans and was operated at less than half this capacity without any prospect of the load's increasing to any extent in the near future. The motors on the fan and the large ice machine were exchanged to give the necessary factor of safety for the ammonia compressor unit.

The ice-plant engineer now suggested that with the increased size of the motor the speed of the machine could be increased to about 160 r.p.m., which would give 60 per cent more capacity and so enable them to make all their own ice and still have a large reserve capacity.

Putting the Drinking-Water Service Into Service

One of the owners suggested that it might be possible to put the drinking-water system back into service. This required approximately four tons to operate, and the ice-plant engineer stated that it would be quite possible to handle this load and still work the ice tank to maximum capacity if the machine was speeded up to 175 revolutions per minute.

The hotel engineer registered serious protest. A speed of 175 r.p.m., he stated, was criminal. His experience, however, with refrigerating machines had been limited to machines of the slow-speed type, and after visits to several plants around town where he found a number of the same capacity and type of machines running at 200 r.p.m., he finally grudgingly consented to the increase of speed. No trouble was experienced at the increased speed and there was capacity to spare, the machine often being shut down during the night for an hour or two and sometimes longer during cool summer weather. During the night run in the winter, and the late fall and early spring, it was often possible to hold the temperatures with the small machine, after the hardening room and fish freezer had been brought down to the desired temperature.

In figuring depreciation, it is common to divide the original cost by the number of years of life. That is, if the original cost is $1,000 and the estimated life 10 years, the depreciation is figured as $1,000 ÷ 10 = $100 per year. Theoretically, this is not correct for the simple reason that $100 laid aside each year for 10 years would accumulate interest, so that the total could come to more than $1,000 in 10 years. To reverse the statement, less than $100 per year would need to be laid aside to amount to $1,000 in 10 years. For example, if the interest rate were 5 per cent, $79.50 per year would do the trick. However, there is much to be said for the simple method as commonly used. The estimated life is at best only a guess, so refinements are hardly warranted. Moreover, if the life is short, the interest is not a large item. With a long life, on the other hand, the interest mounts up. For example, a $1,000 investment and a 20-year life would give a $50 yearly depreciation by the ordinary method, but only $30.20 if interest at 5 per cent were figured in.

EDITORIALS

F. R. LOW, EDITOR

Do Not Store Energy While Testing

ONE man was killed and another seriously injured while testing an electrically welded tank with compressed air. The tank was about three feet in diameter and twice as long, with dished heads. Both heads were blown out, the welded longitudinal seam ripped open and the sheet laid out practically flat.

We do not know whether their sacrifice was the result of a sublime confidence on the part of the victims in the "unbustibility" of their product, or of ignorance of the fact that they were playing with powder.

The energy stored in compressing air has to expend itself upon something—or somebody—when it is released. It is well, even when testing hydrostatically, to assure oneself that there is no air pocket in the vessel under test. The pressure exerted by the pump should be instantly transmitted to the test gage through solid, incompressible fluid. In this way only pressure, and not energy, is involved. If the pump has to make more strokes than are necessary to fill the vessel completely and take up expansion and leakage, it is generating energy which is likely to flare back.

Possibilities of the Direct-Driven Steam-Turbine Valve Gear

WHERE the main turbine valve is linked directly to the governor so that the energy for operating is derived directly from the movement of the governor weights or balls without the aid of hydraulic pressure or other external energy, the valve gear is usually termed a "direct-acting" or "direct-driven" type. In order to minimize the work required for moving the steam valve and also to produce as nearly a uniform opening and closing force as possible, a balanced or approximately balanced valve is required.

Such gears were originally applied in small turbine units up to approximately seventy-five kilowatts. Larger units were usually built with a plurality of operating valves, requiring too much work in proportion to the governor capacity for direct action, and hence were equipped with auxiliary devices for supplying operating power.

At the present time direct-driven-type valve gears are manufactured for turbines up to three hundred kilowatts and some units up to 2,000 kw. are operated by means of a single balanced-type steam valve.

Although from the point of view of cheapness and simplicity this type of gear deserves consideration, of far greater importance is operating convenience, which increases continually as an economical factor. The advantage of a few simple and accessible parts and ease of adjustment weighs heavily against the disadvantages of larger governor springs, weights and thrust bearings which this gear would require in increased sizes.

Sticking, binding or oscillating of the steam valve produces hunting or surging more readily in the direct-acting type than the externally driven valve gear. The higher steam temperatures produce "growing" of the valve at an accelerated rate, frequently making it necessary to re-machine the valve or seat several times after it is placed in operation until the final growth has taken place. The consequent liability to friction is less favorable to a direct-acting gear than one where power is supplied for valve operation. Friction in the valve-stem packing gland has long been reduced to a negligible degree by using a metallic labyrinth-type gland. It would seem that in view of the simplicity and convenience in both manufacture and operation, direct-driven-type gears could advantageously be developed at increased capacities.

The Diesel Locomotive

HIGH coal prices have again caused the steam locomotive to be placed under severe scrutiny. That the present locomotive is wasteful of fuel cannot be denied, and its position as the principal power for railroad transportation is retained in the face of the admitted deficiency and is due to other factors, such as mechanical construction, ease of repair, long life, fairly low first cost and reliability of service. The locomotive will retain its position in spite of increased coal costs until the railroad authorities find some other source of power having the advantages possessed by the steam locomotive.

Considerable interest has been aroused by the adaptation of the Diesel engine to locomotive drive. Several units have been placed in service on the Prussian State Railways, and the system is being advocated for American roads. That the perfected or even workable machine has not been produced is evidenced by the extensive alteration in design of each new unit.

The question of drive from engine to wheel has not been settled definitely, but for large units a hydraulic clutch is undoubtedly the only feasible method. For small branch-line units the engine-generator-motor combination has the merit of complete flexibility, although somewhat expensive.

That the Diesel is the proper prime mover for railroad work is not conclusive. As the railroads are at present operated, the idle time of a locomotive is large, and during this period, while the fuel cost of the Diesel ceases and the steam locomotive is forced to consume a certain amount of coal for banking, the overhead charges are going on at the same rate as during the running period. That the Diesel first cost, and as a consequence its overhead charge, is higher than in case of a steam locomotive is conceded by all.

It would seem that the relation of the Diesel to railroad work is quite similar to its relation to the merchant marine. While the operating costs of the motorship are far less than those of the steamer, unless the vessel be at sea a large percentage of the year the operating savings cannot offset the increase in overhead.

On lines where the traffic is such that locomotives are in running service almost constantly, it seems that the Diesel offers inducements. For this reason branch lines in close proximity to large cities could with profit adopt the oil engine. The same reasoning applies to branch lines where the traffic is so small that a two-car train is ample to meet the requirements. In this latter case the reduction in operating costs is great by reason of the elimination of a large part of the train crew.

Who Shall Get an Education?

"THERE is such a thing as an aristocracy of brains, made up of men intellectually alert and intellectually eager, to whom increasingly the opportunities of higher education ought to be restricted if democracy is to become a quality product rather than simply a quantity one and if excellence and effectiveness are to displace the mediocrity toward which democracy has such a tendency to skid." These words spoken by President Hopkins at the opening of Dartmouth College last fall, were given much newspaper publicity and excited comment pro and con. This was natural and proper in view of the fact that the address as a whole, and the quoted portion in particular, stated a position at variance with that of many intelligent citizens.

President Hopkins was doubtless thinking, in the main, of the general "cultural" courses. Engineers, whether or not they have had the privilege of technical schooling, will be interested in the reaction to this address in the minds of those directly concerned with the problems of technical education. Should engineering schools go in for an "aristocracy of brains," or can they do more for their country by working for the widest possible diffusion of technical knowledge?

To get the viewpoints of the educators themselves, the *McGraw-Hill Book Notes* sought the comments of the presidents and deans of representative engineering schools. As published in a recent issue of that periodical, the replies exhibit a variety of opinions on the subject.

On one side we have Director William E. Mott of the College of Engineering, Carnegie Institute of Technology, with this statement: "It seems certain that the leaders in engineering will agree . . . that our efforts in the endowed schools must be directed toward training the exceptional student. The engineering profession needs more leaders if it is to receive the recognition it deserves." Much the same idea was expressed by Dean H. J. Hughes of the Harvard Engineering School, when he said: "The engineering colleges are graduating too many young men who have not shown a real interest in, nor an adequate capacity for, their chosen work."

The majority of the answers, however, failed to agree in full with President Hopkins' main contention. Many felt that, while special provision should be made for the training of brilliant students, the engineering colleges would fall short of their opportunities if they failed to offer something for the plodding workers who had set their minds on becoming engineers. According to Dean Dexter S. Kimball, of the College of Engineering, Cornell University, both quality and quantity are needed for the best interests of a democracy, and the quantity should be limited only by the financial capacity of educational institutions.

In all this discussion, interesting as it is, we should not lose sight of one important fact, which is that college training and education are not synonymous. Anybody who has observed knows that some of the best-educated men in America today never went to college and that many college graduates fall short of being educated men in any broad sense. This is nothing against the colleges, particularly the engineering schools. Their magnificent accomplishments speak for themselves. But the fact remains to comfort the man outside, that he can become, not merely a good engineer, but one of the best, if he will only grasp those opportunities for self education that touch him on every side. Incidentally, "self education" is the only kind worth while anyway, whether it be acquired within college walls or in a boiler room.

Personal Element in Plant Operation

RAPID advances in power-station practice, in higher steam pressures and in the size of units during the last few years have tended to eclipse the practices and ingenuity required of those operating the older plants that are forced to compete with those of modern and more economical design. When it is considered what has been accomplished in some of these older stations through remodeling of equipment and careful analysis of operating practice one is led to question whether they are not too frequently discarded.

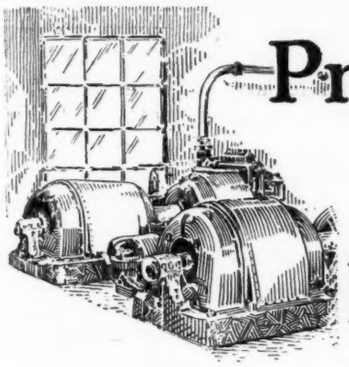
A case in point is the steam plant of the Kansas City Railways, as related elsewhere in this issue. Here was a plant twenty years old. Financial considerations had made it impossible to build a new station or to spend money for new equipment. Interruptions were frequent and because of these it was fast losing its commercial load and being forced to the wall. Yet through a close study of the conditions it was possible to effect a reduction of thirty-five per cent in generating costs by improved operating methods and the building up of an efficient personnel. Moreover, save for the overhauling of existing apparatus and the addition of a few accessories, this was accomplished without the purchase of new equipment.

The principal element in the success of the plan appears to have been the selection, from among its existing employees, of those who were inclined toward teamwork and the creation of a personal interest in the plant through posting the daily performance in all departments. In other words, by taking the men into its confidence the management established a spirit of partnership and co-operation.

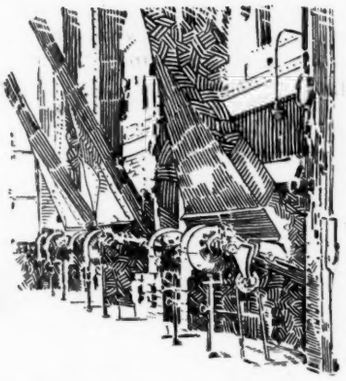
Here is a striking illustration of the human element in the performance of a plant. Other managements would do well to profit by the experience of the Kansas City Railways.

The balmy days of spring are approaching, and will soon be on us. Then the engineer who has been using his spare moments during the winter to put every part of his plant in first-class operating condition is the one least likely to have his peace of mind disturbed and his spare moments broken up by epidemics of trouble. Those who have not yet been able to do all they planned along this line may still find time to accomplish much before the hot weather sets in.

The question is not whether the price of gasoline is going to one dollar a gallon in the immediate future, but whether there is anything to prevent its purveyors from putting it there if they dare to.



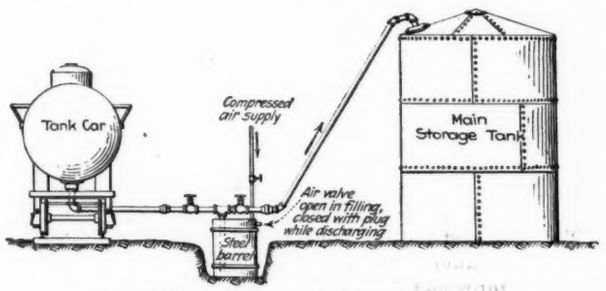
Practical Ideas *from* Practical Men



Compressed-Air Oil Unloader

In a small semi-Diesel-engine power plant, to enable the fuel to be handled by the carload, a 10,000-gal. vertical welded sheet-steel tank was installed. It was set high enough above the engine-room floor line to allow the daily fuel supply to flow by gravity to the engine tanks.

This tank height proved to be too great for gravity filling of the storage tank from the car, and to avoid the


Tank Car
Compressed air supply
Main Storage Tank
Air valve open in filling, closed with plug while discharging
Steel barrel

UNLOADING OIL BY COMPRESSED AIR

expense of an unloading pump, compressed-air unloading was resorted to. As the tank car could not be made airtight, a steel barrel was used as a container. The oil flowed into the barrel from the car by gravity, and was then blown out into the storage tank by air from the plant compressor. Inasmuch as one carload would last eight or ten months, this was not objectionable, and the arrangement was far cheaper than a pumping outfit.

COLIN K. LEE.

Bowling Green, Mo.

Troubles with a Flat Cooler in a Refrigerating Plant

Recently, the writer ran across some trouble in a distilled-water ice plant, that brought out an interesting fact not often thought of.

In this type of plant the distilled water from the steam condenser is pumped to a reboiler located as high as the building will permit. After the distillate is reboiled, it passes by gravity through the water cooler or so-called flat cooler, deodorizer and forecooler to the ice-can fillers.

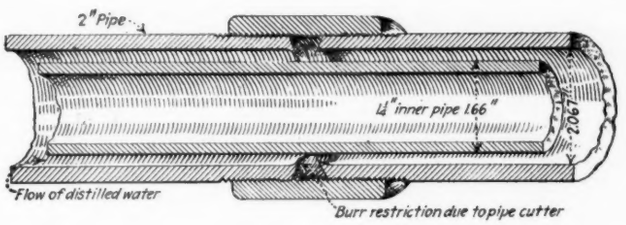
The flat coolers in this particular plant were of double-pipe construction; that is, one pipe inside the other. The outer pipe was of 2-in. and the inner of 1¼-in. nominal diameter. During the hot months there always was difficulty in getting enough distilled water through the system to fill the ice cans. Consequently, some distilled water went to waste out of the reboiler overflow, and some raw-water tombstone ice had to be made to keep the plant's output up to the demand.

Whenever opportunity permitted, an attempt was made to find the stoppage in the distilled-water system, for there was enough hydraulic head to force the comparatively small amount of distilled water through the pipes and cooler. It was not until this winter that the trouble was definitely located and eliminated.

Steam was kept up in the plant all winter so as to make conditions comfortable while alterations and repairs were being made. As there was no heating system, temporary radiators were needed. The double-pipe flat cooler was chosen for one of the radiators, the steam being admitted between the two pipes. A drain valve on the bottom was "cracked" to allow the condensate to escape. When live steam was turned into the cooler, it was found that there was no free flow through the coils, and we believed that the cause of the stoppage trouble was in the cooler.

When opportunity presented itself, the cooler was dismantled and the inner 1¼-in. pipes were pulled out. The 2-in. pipes were then examined by holding a light at one end and sighting through the other end. All appeared clear, and the trouble of taking the coil apart seemed to have been in vain until a dark ring was noticed on the insides of three of the 2-in. pipes.

On closer examination, it was seen that these were caused by ordinary pipe couplings. For some reason,



BURRS STOP FLOW THROUGH COILS

when the coils were first assembled, three of the 2-in. pipes had been pieced together, and, moreover, had been cut with a dull pipe cutter. The burr caused by the cutter on the inside of the pipe had not been removed, and the pipe cross-sectional area was reduced slightly. When one considers that the annular space between the pipes is only two-tenths of an inch and that a burr will half close off this space, it was no wonder there was a partial stoppage of flow. When the burrs were removed, there was a free flow of steam through the cooler, and it is believed that the distilled-water-flow problem has been solved.

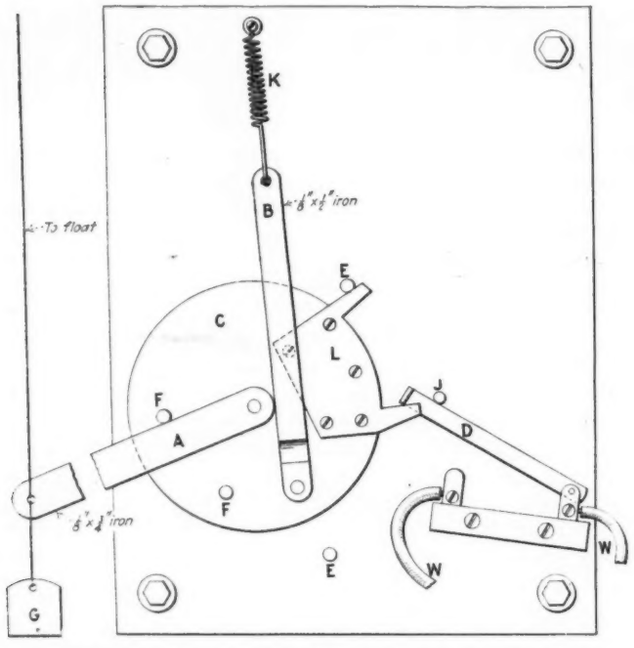
V. R. FROID.

New York City.

Improvised Automatic Float Switch

The illustration shows a float switch in use in our plant, which is easily and cheaply made of materials found in every power plant. It is used in connection with a motor-driven centrifugal pump furnishing water to a water softener.

Referring to the illustration, *C* is a hard-rubber pump valve which makes a good insulator; *A* is the shifting



DETAILS AND ASSEMBLY OF SWITCH MECHANISM

lever and is connected by a small cable to a float in the water softener; *B* is a bar connected as shown to a coil spring which gives the mechanism the snappy action required in opening and closing the switch. The switch is connected by leads *W W* to the magnet coils of the motor starter.

The stop pins *E*, *F* and *J* are for limiting the travel of the mechanism. The part *L* is made from a piece of ⅛x2-in. band iron and riveted to the hard-rubber pump valve.

The switch is shown in the open position and the motor is at rest. When the water in the softener falls to the predetermined level, the float, also falling raises the lever *A*, which, bearing against the pin *F*, turns the disk until the pin at the lower end of the bar *B* passes the center; when a quick snap is given to the disk by the action of the spring *K*, causing the projection plate *L* to strike the switch blade *D* with a quick motion, closing it with a snap.

As the water rises in the softener, the weight *G* brings the lever *A* down and turns the disk in the opposite direction until the pin in the bar *B* again passes over the center, when the operation is reversed and the switch is opened.

The quick snappy action of the mechanism breaks the circuit instantly, and there is no chance for the current to arc across the switch points. The blade *D* is bent at right angles at the end so that there is a wide section for the projections on *L* to strike on, insuring positive action every time the disk is turned. The pin *J* keeps the switch blade from being thrown too far. The bar *B* is offset at the lower end in order to clear parts *A* and *L*. The whole is finally mounted on a piece of plank and bolted to the wall. The switch has been in use in our plant for over a year and has never yet failed to function properly.

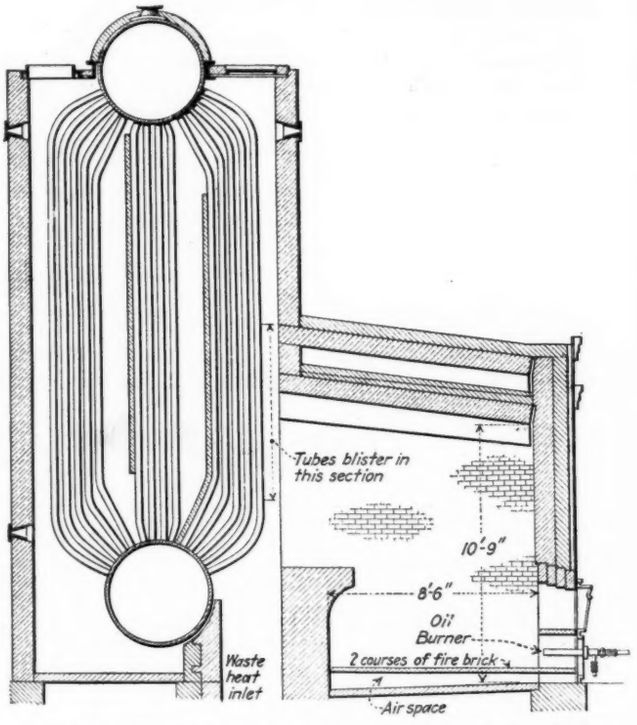
W. W. CARY.

Northfield, Minn.

What Causes Tubes To Blister with Oil Burning?

We have had considerable trouble due to the burning out of the tubes of our water-tube boilers, which are of the vertical type. Each boiler has approximately 5,000 sq.ft. of heating surface and is fired through a Dutch oven, as shown in the cut.

These boilers were originally installed for waste heat from one 80-ton open-hearth furnace, but as we did not get enough waste heat to make it pay to operate them as such, they were turned into direct oil-fired boilers. The oil is supplied to the burners at 110 lb.



LAYOUT OF FURNACE AND LOCATION OF BURNERS

pressure and a temperature of 160 deg. F. The steam pressure used is 135 lb. gage.

The tubes burn out at a point about three feet above the bridge wall, and up to date we have put in about 200 tubes. Possibly some readers of *Power* who have had a similar experience could give a practical method of overcoming this trouble.

C. W. HILL.

Hamilton, Ohio.

Hydro-electric engineers are at present investigating the possibilities of two large water-power schemes in the Katanga District, Belgian Congo. One is a 60,000-70,000 hp. project on the Lualaba River and the other involving 50,000 hp. on the Lufira River. The latter entails a mass-concrete intake dam and an earthen reservoir dam 17 meters high. The schemes are only as yet in the project stage, says Consul Charles J. Pisar, Cape Town, in a report to the Department of Commerce.

Comments from Readers

Can Return Traps Be Used for Boiler Feeding in Connection with Venturi Meters?

One of the departments of *Power* is devoted to the discussion of power-plant troubles, operating methods, etc., therefore I am taking the liberty of asking for an opinion on the method of operating return traps as boiler feeders in connection with venturi meters, if this is possible.

No doubt some readers of *Power* can give some practical information on this subject. G. W. AKERS.

Detroit, Mich.

Removing Scale from Pipes with Mechanical Tube Cleaner

In the Feb. 20 issue H. M. Toombs describes how he has cleaned heavy scale formation from a 6-in. feed-water line by means of muriatic acid.

Although the need for methods of cleaning scale out of feed-water piping is encountered frequently, I believe that but few engineers realize that a tube cleaner of the ordinary boiler-tube type is successfully used for this service, and quite a number of plants employ such cleaners in various sizes every few years to remove scale from feed water and other lines of piping that scale. Such tube cleaners are obtainable in special large sizes for cleaning pipe up to as large as 12 in. They are specially constructed for the work, being equipped with special large cutter heads, and a single size of motor can be arranged with sleeves and various sizes of cutter heads, allowing it to be used in different sizes of pipe. These cleaners are operated by water, air or steam, like the ordinary boiler-tube cleaner.

I can cite the case of a well-known iron and steel company in Alabama that recently used one of these special 6-in. air-driven tube cleaners for the cleaning out of a feed-water line. They got better service than they ever expected, cleaning out scale 1½-in. thick at the rate of a little better than one foot a minute.

Jeannette, Pa. C. W. KALBFUS.

Curing Commutator Troubles

I should like to comment on the article by C. K. Lee in the Feb. 20 issue, "Curing Commutator Troubles." Undoubtedly his trouble was caused by high mica between the commutator bars. My experience with machines that have developed the same trouble has been as follows:

In the majority of cases the manufacturer ships his machines fitted with the right grade of brushes, but after the original brushes wear out, in many cases they are replaced with any old carbon that may be available, and I have seen even old dry-battery carbon used for this purpose. There is now available a large variety of brush carbon, and a letter to any of the manufacturers, stating details of machine on which the brushes are to be used, will bring the right grade.

Returning to Mr. Lee's trouble, I should judge that his case is either that the present brushes are not of the same grade as were supplied with the machine, or that the commutator was undercut at first and has since been turned down and not undercut, or perhaps the commutator bars have worn flush with the mica.

In any event he can purchase brushes to work on flush mica commutators that are slightly abrasive and will keep the mica down flush with the bars; or better still, undercut the mica and use a non-abrasive brush. This in my opinion will give the best results as there will be less copper and brush wear. A. J. MORRONI.

Denver, Colo.

Theory and Practice

The editorial "Theory and Practice," in the issue of March 14 follows the general trend of previous discussions under the same title which have appeared in the columns of engineering journals and tends rather to overemphasize the importance of making a distinction between theory and practice in connection with the application of these terms to engineering.

Pure science admits of a definite distinction between the two. Here a theory may stand for years, finally to be substantiated or disproved through the development of refined laboratory and experimental methods or new methods of analysis. In this realm of thought, then, it would appear essential to be mindful constantly of the possible inadequacy or incompleteness of a theory and to accept it only upon this basis. Its application would be made more or less tentatively and not only for the purpose of determining new truths by its use in untried fields, but also for the purpose of testing its accuracy in application to conditions involving new factors. In pure science a theory may thus be accepted and its application be considered as good practice until developments in the science show that modification is necessary in order to co-ordinate it with experimental fact.

Engineering is essentially a constructive art and builds from known facts. What is commonly known as the theory of engineering is a compilation of well-understood facts derived from experience and experimental observation between known limits. The application of the laws and rules formulated from these known facts to the problems involved in the modifying of the energy and material resources of the world to forms suitable for human use is the function of the engineer in so far as his purely technical activities are concerned.

Predetermination of the performance of an engineering structure is made from a knowledge of the performance of the individual elements of which the whole is to be composed, and no essential feature may be left undetermined through the application of a theory about which there is any skepticism. The controlling factor is money and regulates for accuracy. Theory and practice of engineering are thus largely synonymous terms; at any rate the theory and practice in engineering are

sufficiently well co-ordinated to enable design, operation and performance of machines and plants to be worked out in theory and realization of theoretical figures approached to a high degree in practical operation.

The statements contained in the editorial regarding the inability of many persons of technical training to operate successfully is undoubtedly true, but should be taken as an indication of a defect in their training in or understanding of engineering theory rather than as an emphasis on the difference between theory and practice.

I do not agree with your contention that there are designers who are unable to operate a plant which they have designed as successfully as persons not connected with the design. The trained faculty of the designer enables him to determine quickly the essentials of performance and give them their proper weight and should enable him to obtain operation at maximum economy and efficiency. JOSEPH P. DUNCOMBE.

Washington, D. C.

Should Manufacturers Purchase Their Power from a Central Station?

May I make some observations on the question under discussion in *Power* on the problem of whether factories requiring some steam for process work, etc., should or should not purchase their electric power from a central station?

There can be, of course, no general answer to this question. There are cases, chiefly water power it is true, where central-station electric power is purchased and then used in an electric boiler to make steam.

On the other hand, there are cases where the central station cannot sell power to the factory, and there are cases, such as bleacheries, etc., where the factory has a surplus of power which it sells to the central stations. In between these extremes there are many other possibilities. Incidentally, it is important to note that even if a factory decides to make some or all of its power, a connection between the factory switchboard and the central station will (unless the first cost of the connection is excessive) never do any harm and will often be of great value.

We cannot imagine that for each and every hour in the day or year the amount of steam needed for the process work shall exactly balance that needed to make the electric power. When they are not in balance, either the central station can be selling some of the power at a profit or else it can be buying some power from the factory at a price advantageous to both.

This, for instance, is undoubtedly what occurs in the case of the big printing and bleaching plant in one of the cotton-mill centers in New England where, ordinarily, the central station is purchasing several thousand kilowatts of power, but on occasions such as of overhauling or repairs or occasional special work, the central station will sell power.

No general answer can be made. Each case must be considered by itself, and not only does each case mean each factory or plant, but the conditions change every year or oftener, and even if a plant continues to do the same work year in and year out, the cost of coal, labor, price of purchased power, etc., change.

Now, accounts are kept primarily, of course, to know the grand total of expenses and income, and in addition accounts are subdivided relative to different items such as power, light, freight, rent, etc. Subdivision of the accounts, however, is likely to result in a great waste of time and effort unless the object of the accounting system is kept in mind.

The object of an accounting system is not to know what the various items such as power, light, rent, etc., cost in the past. What they cost in the past will not make any difference. The dollars expended in the past are water that has gone over the dam or through the wheel; the dollars are gone. There is no need to bother about what they were except to the extent that knowing what they were in the past may guide the management in deciding what to do in the future.

Suppose the accounts show on the books that power cost last year 2c. per kilowatt-hour, and the central station offers it at 1c. or at 3c. The fact that it cost the factory 2c. last year doesn't mean anything at all. The problem for the management is, "If I keep on as last year what will my total expenses of all kinds be next year. If, on the other hand, I buy central-station power next year, what will my total expenses of all kinds be?"

The management must decide the question for next year, and what it happened to cost last year is merely an indication. The management that adopts a hard-and-fast classification of accounts and then follows the indications without really studying what they mean is likely to lose out. The management that remembers that the accounts of last year tell only a part of the story will make a much wiser decision for the future. There are, for instance, plants that consider that the advertising value of the fact that they make their own power warrants them in spending more than they would for central-station power.

Some plants consider that for their purposes their own plants are more reliable than the central-station supply. On the other hand, there are a great many plant managers who think, and perhaps know, that they can save money by making their own power rather than buying it, but they also feel that if they buy power and put their time and effort on their own business, they can make even more money than they can save by making their own power.

Still another item that comes in some cases—for instance, in cotton-mill work—is the fact that central-station power, though it may cost more than from an isolated plant, will have so much more even speed that the output of the mill will be enough greater to make up for much more than the extra cost.

This feature of constant speed would not apply in the same degree to other businesses.

Another feature of value in the case of central-station power is the opportunity to do night work without having to arrange for a special tour of duty of the engineer and fireman. This may indicate that it may be cheaper in the long run and considering the total expenses, to buy power even if the purchased power costs more than the privately made power appears to cost on the books. This particular case of night work may, however, be an indication of the value of making a connection with the central station so as to be able to buy power at certain hours even if not all the time.

All these things that I have noted are almost impossible to put down in an accounting system, and the point I wish to make is that the results of an accounting system showing the costs for the past are likely to be misleading. If the accounts as kept show that the cost last year was, say, 2c. per kilowatt-hour, this doesn't tell the manager how that item was made up nor does it tell him what it is going to be next year. For in-

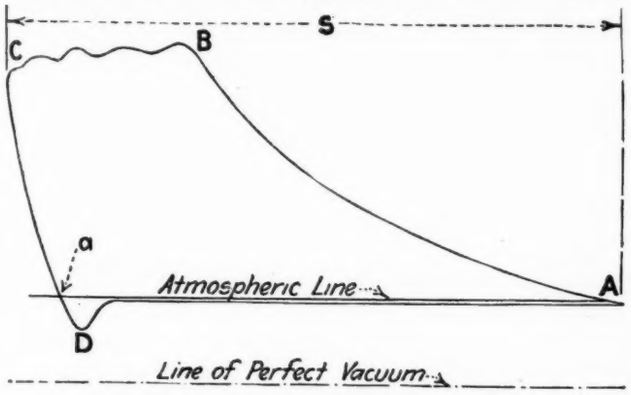
stance, will the amount of depreciation or of rent or other items be the same next year as last, and how will they be affected by the purchase of power as compared with making it, or vice versa?

If the accounts show the totals—as, for instance, the tons of coal and dollars paid for the coal, the kilowatt-hours, the pounds of steam, also the number of employees, etc., without any attempt to allocate these for the past year as between power, light, steam, rent, freight, etc.—then such accounts are much easier to use in forming a judgment for the next years, than when the accounts are the results of some arbitrary division charging to power, light, steam, etc.

R. S. HALE,
Supt. Special Research Department,
Boston, Mass. Edison Elec. Illuminating Co.

Determining Air-Compressor Capacity

With reference to the inquiry in the Jan. 30 issue as to determining air-compressor capacity, the method given is approximate only, as it does not take into account the heating during suction nor leakage past piston rings and valves during compression. These losses in



TYPICAL AIR COMPRESSOR DIAGRAM

the average compressor will probably reduce the indicated volumetric efficiency by at least 5 per cent. The real capacity of the compressor would then be as follows:

$$\frac{Displacement \times aA}{S} \times 0.95$$

This slippage efficiency will vary with every compressor and even with the same compressor so that at best the method is far from accurate.

The most satisfactory and accurate way of determining the capacity of a compressor is by means of a low-pressure nozzle test, by which accurate results can be obtained. PAUL A. BAUMEISTER.

Flushing, N. Y.

Preventing Sparking at Brushes

In the Feb. 27 issue, P. Bumpus explains how he stopped the sparking at the brushes by applying engine oil to the commutator.

There are times when an application of oil on the commutator will stop the sparking, especially on machines fitted with carbon brushes, and when the spring tension is too great the oil will temporarily reduce the friction and heat. But this treatment, fortunately, is becoming a thing of the past, as the presence of oil in time aggravates the existing evil.

If the generator is properly balanced, the commutator ground and polished to a smooth finish and equipped with the proper grade of brushes, and the brush tension adjusted correctly, there will be no cause for sparking when operating under reasonable load conditions.

New Bedford, Mass. R. G. SPOONER.

The article, "Preventing Sparking at Brushes," in the Feb. 27 issue brings to mind a similar experience with a compound-wound generator of the same size mentioned in the article, and the sparking was overcome by the following method:

I put about one-half inch of gas-engine oil in a tin cup and placed it on a stove. The brushes were then bunched and tied together with their ends even and stood with the beveled ends in the oil, which was heated to a boiling temperature. They were allowed to remain in the hot oil for about an hour, after which they were wiped dry and put on the machine. This treatment cured the sparking. A soaking of this kind will cause the brushes to absorb enough lubrication to run from six months to a year and then the treatment has to be repeated. F. E. MYERS.

Charleston, W. Va.

Trouble from Priming

With reference to the inquiry of C. J. G. in the Feb. 13 issue as to the cause of priming in his portable boiler, this may be due to a hole in the dry pipe that carries the steam from the dome through the steam space of the boiler to the steam chest (similar to a locomotive).

A hole in this pipe may allow water to be taken in when the water level is high in the boiler or when the engine is not level. It is usually caused by corrosion, freezing up and cracking, or it may be due to the pet cock on the bottom of the pipe being left open or knocked off while cleaning the boiler.

If the pipe is badly corroded or cracked, it should be renewed, or it can be plugged and a new line connected from the dome to the steam chest on the outside of the boiler. R. F. BENNEIT.

Dayton, Ohio.

Water-Tube Boilers at Sea

I was interested in the letter, "Water-Tube Boilers at Sea," by F. W. Dean, in the Feb. 27 issue, because during past years I have noticed how the water-tube boiler is replacing the fire-tube and I have wondered why it is. It seems to me that the principal reason is that the manufacturers of the former are much more energetic in the matter of publicity.

On looking through technical publications, anybody who is acquainted with boilers cannot fail to be struck by the fact that few manufacturers of fire-tube boilers advertise. If any boiler advertisement is to be seen, it is that of a water-tube boiler.

Naturally, readers are led to believe that the water-tube boiler is superior to the Scotch boiler not only in weight, efficiency and strength, but also in safety. However, I agree with the opinion expressed by Mr. Dean that the increase in safety is not one of the reasons for the increase in the use of water-tube boilers at sea. What causes me to marvel is—the wonderful powers of well-directed and consistent advertising.

Newark, N. J. F. M. REILLY.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Cracking of Diesel-Engine Pistons

What causes a piston head to crack on a Diesel Engine? L. P.

Cracked pistons usually are caused by very high temperatures resulting from imperfect cooling or overloading of the engine. Small cracks may occur from alternations of expansion and contraction of the piston material, due to overheating for a short period and, once started in this manner, the cracks increase in extent with cylinder temperatures considerably lower than that which induced the original fracture. There is a limit of size for successful operation of pistons without being water-cooled. Where repeated renewals are required of pistons that are not water-cooled, and the regular cooling system operates properly, the remedy would be to reduce the load on the engine.

Number of B.t.u. Delivered for One Cent

If a coal analysis shows 11 per cent moisture, 9 per cent ash and 13,050 B.t.u. per pound of dry coal, and the cost of coal delivered is $10 per ton, how many B.t.u. are delivered for one cent? J. B.

In each ton of 2,000 lb. of coal delivered, containing 11 per cent moisture, there would be $(1.00 - 0.11) \times 2{,}000 = 1{,}780$ lb. of dry coal costing $10. Therefore the cost would be 1,000 cents $\div$ 1,780 = 0.5618 of a cent per pound of dry coal, and if each pound of dry coal contains 13,050 B.t.u., there would be 13,050 $\div$ 0.5618 = 23,228 B.t.u. delivered for one cent.

In addition to the moisture's being a dead weight, its presence is detrimental in requiring enough of the B.t.u. delivered to evaporate the moisture and convert it into superheated steam at atmospheric pressure and temperature of the chimney gases. When the stack gases have a temperature of 600 deg. F., each 1 per cent of moisture means a loss of about 13 B.t.u. per pound of the dry coal delivered, or about 1 per cent of the heat value of the coal for every 10 per cent of free moisture present in the coal.

Relation Between Position of Brushes and Voltage of Generator

In a direct-current non-interpole generator, what relation does the non-sparking point for position of brushes bear to the voltage? In other words, should this point (without moving field rheostat) be where highest voltage is registered, on no load? W. G. H.

In a direct-current non-interpole generator there is no relationship between the non-sparking point for position of brush and the voltage. Of course, at no load the brushes can be set on the mechanical neutral and the machine will generate a maximum voltage, for a given setting of the rheostat. However, in a non-interpole machine, the mechanical neutral may not be the non-sparking position for the brushes when the machine is under underload. To put the brushes in a position where they will operate without sparking may require shifting them ahead of the mechanical neutral, and this position will have a tendency to decrease the voltage of the machine below that which might be obtained on the mechanical neutral. Shifting the brushes back of the mechanical neutral is likely to cause sparking, but will tend to increase the voltage of the machine. In setting the brushes, do not consider the voltage at all, but put the brushes in a position where they will operate best.

Increase of Compressor Load with Higher Suction Pressure

If, as is generally claimed, the horsepower per ton of refrigeration decreases as the suction pressure is increased, why does the kilowatt-hours reading of a motor-driven compressor increase with an increase in the suction pressure? R. L. A.

To illustrate this problem, assume that the suction pressure is 5 lb. gage and the discharge pressure is 165 lb. gage. The theoretical horsepower per ton is 1.46. If the suction pressure be increased to 20 lb. gage while the head pressure is kept the same as before, the horsepower per ton becomes 1.03. The horsepower per ton has then decreased 1.46 — 1.03 = 0.43.

But with 5 lb. suction each cubic foot of ammonia vapor handled by the compressor does a duty of 0.18 ton of refrigeration per minute (a duty of one ton is 200 B.t.u. removed per minute). With 20 lb. suction the duty has increased to 0.29. In other words, the output of the compressor has increased 60 per cent.

If the plant is a 100-ton plant, at 5 lb. suction the theoretical input would be $100 \times 1.46 = 146$ hp. With 20 lb. suction the duty is 160 tons and the input becomes $160 \times 1.03 = 165$ hp. To hold the motor down to its rating, the speed of the compressor must be reduced.

Noisy Water Pipes

What causes a loud rumbling noise in water pipes of our building whenever water is drawn above the first story and a sharp hammering noise when the water is turned off? P. R.

When water is supplied through a throttled connection, the reduction of pressure is accompanied by liberation of air. Hence when there is a throttling from part closing of the supply cock or valve, or sudden contraction in the supply end of a pipe line, the water in the line contains bubbles of free air that are not re-absorbed unless the water is allowed to stand in the line with accumulation of pressure for a considerable

time. When a tap is reopened at the discharge end of the line, after the pressure has become built up, re-expansion of the air bubbles causes churning and water hammer, with a rumbling sound that is transmitted to all parts of the piping system. When the discharge is suddenly closed, water hammer results from promptly bringing the water to rest. The rumbling noise during drafts of water can be prevented by sufficiently enlarging the supply or reducing the rate of discharge at the end of the line so there will be less-sudden reduction of pressure. Hammering from sudden stoppage of the discharge can be reduced by providing an air chamber, formed by extending the riser 10 to 20 times its diameter above the highest outlet.

Setting of Safety Valve for Minimum Boiler Pressure

Assuming that a pressure of not less than 85 lb. is to be carried on a boiler, at what pressure should the safety valve be set to blow off? P. P.

To prevent a safety valve from chattering and pounding on its seat, the valve must be so designed that it will remain open until the boiler pressure has become reduced below the pressure required for the valve to "pop" open. In direct spring-loaded safety valves of approved design the amount of this drop of pressure, called the "blowdown," is adjustable, and the pressure at which the valve is set to open must be enough to cover the least running pressure, plus the blowdown.

State, municipal and boiler insurance regulations for the operation of boilers usually require that the greatest blowdown shall be not less than 4 lb. per sq.in. for safety valves set to pop at 100 lb. or less; not less than 6 lb. for pop pressures 100 to 200 lb.; and not less than 8 lb. for valves set to pop at 200 lb. or more. Accordingly, if not less than 85 lb. pressures is to be carried and the valve is adjusted for the minimum blowdown of 4 lb., the valve should be set to blow off for at least 85 + 4 = 89 lb., of course assuming that the boiler is capable of safely carrying the pressure at which the valve is set to open.

American Practice in Rating Turbo-Generators

A recent article in *Power* describing an electric station at Paris, gave the ratings of the turbo-generator as follows: Most efficient load, 30,000 kw.; full load (maximum continuous), 40,000 kw.; maximum load (2 hours), 45,000 kw. This rating shows a 2-hour overload of 12½ per cent in excess of the continuous capacity. Does present American practice in the design of generators give similar ratios? F. W. C.

The larger machines are designed to meet the specifications of customers, most of whom seem to prefer a maximum efficiency of 75 to 80 per cent of full load, which corresponds to the Paris rating. The machines, however, have a maximum continuous rating with no overload guarantee. This is due to the fact that the central stations find that such machines correspond better to their requirements than any other. It is the general American practice to so rate machines.

The machines are designed with a certain margin of safety, both mechanically and electrically, at their maxumum output, and with proper provision for ventilation of the generator there is no reason why this load cannot be carried continuously rather than for two hours, at least that is the American view.

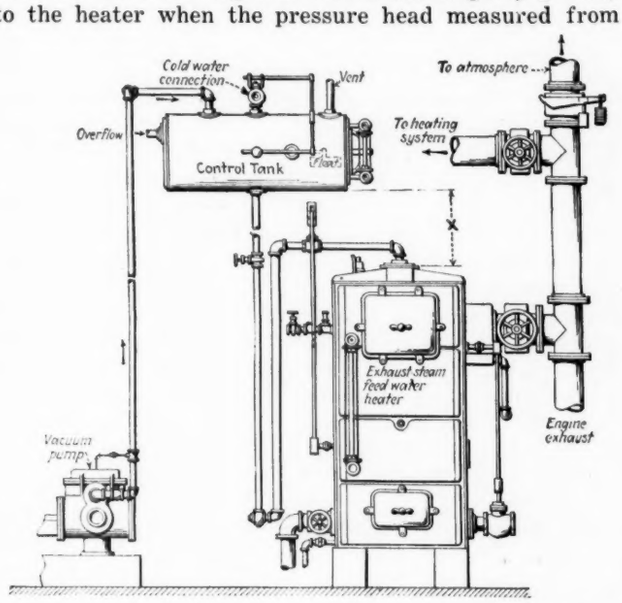
On smaller machines a large manufacturing company guarantees maximum efficiency at maximum load while others have their maximum efficiency on the smaller machines also at 75 per cent of full load.

An overload of 12½ per cent for 2 hours is not generally used or recognized in the United States. The standard A.I.E.E. rating is one based on maximum continuous operation. Of course, special guarantees for overloads for short periods may be given in certain cases, but this is not the usual practice and cannot be considered as standard. An overload beyond the maximum continuous rating would in many cases mean increasing the excitation voltage above normal in order to maintain the generator voltage.

Elevation of Tank for Discharge to Heater

In a plant with a vacuum heating system the returns are discharged by the vacuum pump into an elevated tank from which the water is delivered by gravity to an open type of heater. What is the rule to determine how high the tank should be for successful operation against a pressure of 4 lb. gage in the heater, where the temperature of tank water varies from 140 to 160 deg. F. F. H.

With the arrangement as shown in the figure, the water in the receiving tank would discharge by gravity to the heater when the pressure head measured from



ARRANGEMENT OF TANK FOR DISCHARGING TO HEATER

the top of the heater to the level of water in the tank is equal to the back pressure in the heater plus the head required for pressure to overcome pipe friction. When the tank water has a temperature of 160 deg. F., a cubic foot of the water weighs 61 lb. and therefore a column 1 ft. high would exert a pressure of 61 ÷ 144 = 0.424 lb. per sq.in. Allowing 1 lb. pressure required to overcome pipe friction and 4 lb. back pressure, the required height would be (4 + 1) ÷ 0.424 = 11.55 ft. or about 11 ft., 5 in. But to cover such contingencies as greater loss of pressure from partly throttled valves and temporary increase of the back pressure it is customary to allow a difference of level of 3 ft. from the top of the heater to the under side of the tank for each pound of back pressure carried in the heater, so that a back pressure of 4 lb. gage would call for the dimension X to be 3×4 or 12 ft.

Easy Lessons in Engineering

How to Transform a Formula

The "easy lesson" in the Feb. 13 issue told how to use an engineering formula already constructed by somebody else. That in the March 20 issue showed the method of constructing a formula. The present article goes one step farther, and explains how a formula may be transformed, or "turned around," into the most convenient shape for a particular problem.

That is, it explains how the various quantities in a formula may be so shifted as to get the unknown quantity on one side of the equality sign and everything else on the other. It is important to know how this is done, because available formulas are often not in convenient form for the problem at hand.

To illustrate the method, consider the following formula derived in the March 20 article:

$$G = 0.0034 D^2 H$$

In this formula G gives the capacity in gallons of a vertical cylindrical tank whose height is H inches and whose diameter is D inches. This is in the most convenient form for its originally intended use.

Here the height and diameter were given, and it was desired to find the capacity in gallons. The same formula, with simple changes, can be used to find any one of the three quantities (G, D and H) when any two of them are known. The formula as it stands is convenient only for figuring G, but it can easily be turned into two other formulas for figuring D and H respectively. Suppose we want a formula for finding the height when the gallons capacity and the diameter are given. This can be obtained by making a few easily understood changes in the original formula:

$$G = 0.0034 D^2 H$$

To understand these transformations, remember that this is an "equation." That is to say, what is on the left of the equality sign is always equal to what is on the right. Now if two things are equal, they will still remain equal if both are increased or decreased by the same amount, or if both are divided or multiplied by the same number, or if both are raised to the same power. Likewise the reciprocals of equal things will be equal. We want to get H on the left side of the equation and everything else on the right. This can easily be accomplished if the foregoing relations are kept in mind.

First try dividing both sides by same quantity, H. This gives $\frac{G}{H} = 0.0034 D^2$ and thus gets H over on the left side, where we want it. The next step is to move G over on the right side by dividing both sides by G. This gives:

$$\frac{1}{H} = \frac{0.0034 D^2}{G}$$

Although H is now on the left side, it is in the denominator and not where we want it. Observe that each side is a fraction. If two fractions are equal they will still be equal if both are inverted. For example $\frac{1}{3} = \frac{2}{6}$ and $\frac{3}{1} = \frac{6}{2}$. So we invert both sides of the equation and get

$$\frac{H}{1} = \frac{G}{0.0034 D^2} \text{ or simply } H = \frac{G}{0.0034 D^2}$$

which is the desired formula for H.

Similarly, the original formula for G may be turned into one for D in the following manner:

Original formula ..... $G = 0.0034 D^2 H$

Divide both sides by D^2 ..... $\frac{G}{D^2} = 0.0034 H$

Divide both sides by G ..... $\frac{1}{D^2} = \frac{0.0034 H}{G}$

Invert both sides ..... $D^2 = \frac{G}{0.0034 H}$

Take square root of both sides $D = \sqrt{\frac{G}{0.0034 H}}$

As an application of this last formula suppose that a 1,200-gal. tank must be built in a place where the head room limits the height to 70 in. Find the necessary diameter. Then

$$D = \sqrt{\frac{G}{0.0034 H}} = \sqrt{\frac{1{,}200}{0.0034 \times 70}} = \sqrt{\frac{1{,}200}{0.238}} = \sqrt{5{,}042} = 71 \text{ in.}$$

Next, suppose we wish to find the diameter of a vertical cylindrical tank that is to hold 620 gal. and have a height 20 per cent greater than its diameter. Without algebra this can be solved only by trial and error. With algebra a direct solution is possible. Start with the original formula,

$$G = 0.0034 D^2 H$$

Now we know that H is to be 20 per cent greater than D. In other words, $H = 1.2 D$. Since $1.2 D$ is equal to H, it can replace it in the formula, and we get

$$620 = 0.0034 D^2 (1.2 D) \text{ or}$$
$$620 = 0.0034 \times 1.2 \times D^2 \times D \text{ or}$$
$$620 = 0.00408 D^3$$

To get D^3 by itself, divide both sides by 0.00408, giving

$$\frac{620}{0.00408} = D^3$$

This is the same thing as

$$D^3 = \frac{620}{0.00408} \text{ or } D^3 = 152{,}000 \text{ approximately.}$$

Next take the cube root of each side, giving:

$$D = \sqrt[3]{152{,}000}$$

So the diameter is 53.4 in. and the height is $1.2 \times 53.4 = 64.1$ in. This answer can be checked by putting this diameter and height back into the original formula and solving for the number of gallons.

The Evolution of the Heavy-Oil Engine*

By R. E. Mathot

Contrary to the prevalent belief, it is to the Englishman Akroyd Stuart that we owe the first application of the oil engine working with automatic ignition after the introduction of the combustible into air previously compressed by the working piston. This cycle is quite different from that of Otto or of Beau de Rochas. The Diesel cycle may be regarded as a modification of the Akroyd cycle, for it operates on the same principle. The engine patented by Akroyd in 1890, two years before that of Diesel, burnt the charge at constant volume, whereas the Diesel engine burns it at constant pressure. In other respects the Diesel cycle differs from that of Akroyd only in that the compression is higher, say from 500 lb. to 570 lb. per sq.in. as compared with 42½ lb. to 57 lb. per sq.in. of the Akroyd engine. The higher pressure itself produces a temperature hot enough to bring about the ignition of the mixture.

If during the last twenty years the Diesel engine has been considerably developed, it is because the inventor, aided by scientific ability, found in his own country the financial and technical aid of the large works which he had the good fortune to be able to interest in his ideas.

Objections to Diesel Air Compressor

The Diesel motor, which works on either the two-stroke or the four-stroke cycle, differs from the explosion or hot-bulb motor of the Akroyd Stuart type in that the progressive and gradual injection of the combustible toward the end of the period of compression results in a combustion that is slow in comparison with the rapid action that characterizes the explosion motor. This slow combustion is the result of retarding the flow of combustible oil into the cylinder by means of a valve, the forms of which are infinitely varied. To overcome this resistance, resort is had to the use of high-pressure injection air which is furnished by a two- or three-stage compressor forming part of the engine. In an ordinary Diesel engine with a compression of from 430 lb. to 500 lb. per sq.in., the pressure of the injection air is from 930 lb. to 1,000 lb., while in engines using oils with higher flash points, in which the compression is often higher than 570 lb., the pressure of the injection air may have to be as high as, or higher than, 1,150 lb. per sq.in.

It is necessary to have these exceedingly high pressures in order to overcome not only the resistance of the pulverizer, but the compression pressure as well. The latter is high enough to produce a temperature considerably in excess of that actually necessary to bring about the ignition of the combustible mixture, but it is necessary in order to counteract the cooling that results from expanding the injection air from a pressure of 1,150 lb. into a space containing air compressed to only from 430 to 570 lb. per sq.in. Matters proceed, therefore, in a vicious circle in which an expensive excess of temperature is provided to make up for a loss that cannot be avoided. The injection air absorbs for its compression 10 per cent of the effective horsepower of the engine, and that is why the mechanical efficiency of a four-stroke-cycle Diesel engine is only about 75 per cent. The compressor, which is a delicate and complicated machine, usually comprises two or three cylinders with their mechanical control gears, cooling arrangements, piping, air receivers and valves. In cost it represents from 8 to 12 per cent of the total cost of the engine, while it can be shown by statistics that 70 per cent of all breakdowns and even of the fatal accidents with Diesel engines, are attributable to the compressors and their accessories.

Fuel-Valve Design

Let us now consider the pulverizer of combustion engines and ascertain why it is necessary to have properly regulated mechanical control—which is not the case with the pulverizers as fitted nowadays to explosion engines. The Diesel pulverizer is a piece of apparatus requiring delicate adjustment. Moreover, the needle valve controlling the inlet orifice is furnished with a packing gland which is kept tight against the high pressures by very exact construction and careful attention, failing which the pulverizer leaks and tempts the operator to screw up the packing so tightly as to run the risk of allowing the valve to become fixed in the open position so that it cannot be closed by its spring. Such an accident might have a disastrous effect on the engine, which, under the influence of premature injection of fuel into air compressed to a pressure of 500 lb. to the square inch, might experience, not a slow combustion producing a pressure but little in excess of the compression pressure, but a violent explosion resulting in pressures from 1,000 to 1,200 lb. per sq.in. or higher.

Comparison of Compression Pressures

Diesel-engine builders, therefore, find themselves confronted with the alternative of either making provision for excessive accidental pressures by giving to their engines excessive dimensions or by building them for normal pressures and running the risk of their experiencing anything higher. Such a dilemma has not to be faced by builders of engines working on the Otto cycle, in which, with compression pressures varying between 250 and 300 lb. per sq.in., the explosion, even if it be premature, does not result in pressures exceeding 500 to 570 lb. per sq.in., so that the weight of the engine can be kept comparatively low.

The simplicity of construction of the two-stroke-cycle hot-bulb engine forms the chief merit claimed for it by its supporters. Indeed, the absence of complicated valve gear and the simplicity of the scavenging single out that type of engine as especially suitable for fishing boats and yachts and for motive power in small industries where it would not pay to put skilled mechanics in charge of the power plant.

It is astonishing, however, that the Scandinavian, American, French and English builders who have constructed motors of from 360 to 400 hp., have never departed from the original design and never set themselves to improve these interesting machines from the point of view of thermal efficiency, which is scarcely above 25 per cent, by raising the compression pressure, which varies in different engines from 100 lb. to 210 lb. per sq.in. This would avoid the necessity of having to heat the vaporizer at starting. Neither have they done away with crankcase compression, which is often uncertain in its effect and which results in a loss of lubrication and at the same time involves covering up and hiding from view the heads of the connecting rods, which are so exposed to heat in this type of engine.

Solid-Injection Pressures and Temperatures

As built at the present time, they have no exterior uncooled vaporizer, and the injection of the combustible is made directly into the combustion chamber, which is carefully cooled by water circulation. I have said that a compression of from 500 lb. to 570 lb. per sq.in. results in a temperature considerably higher than is actually necessary to bring about the ignition of mixtures of air and the heavy oils that we are considering. In fact, while these temperatures vary between 1,100 and 1,300 deg. F. in Diesel engines, they scarcely rise to 900 deg. in explosion-engines. Moreover, it is only necessary to raise the compression pressure to, say, from 285 lb. to 340 lb. per sq.in. to insure ignition without misfiring as soon as the combustible is injected. It is true that to the temperature inherent in this compression is added the heat of the cylinder walls and, more particularly, of the bottom of the piston, which is given a certain thickness so as to form a magazine or reservoir of heat. It is by reason of this conjunction of thermal elements that the new engine avoids both excessive compression pressure and injection air. It likewise dispenses with all the complicated mechanism included in the compressor, the air reservoir, the air-injection tubing, and the mechanical control of the needle valve and its gland, of which I have discussed the objections from the points of view of operating charges and first cost.

The hot-bulb engine is, in fact, satisfied with mechanical injection, by means of which the fuel is caused to mingle in a finely pulverized state with the compressed air at the head of the cylinder. And here a difficulty is encountered which, fortunately, has now been overcome. It consists in insuring a pulverization of the fuel to such a degree and into particles so infinitely small that each one is surrounded

*Extracted by the *Engineer*, London, from a paper presented at the International Congress on Liquid Fuels, Paris, 1922.

by sufficient air for complete combustion, so that the whole body of the mixture lends itself to the rapid propagation of the flame.

Actually, the liquid thus pulverized has the appearance of a mist or fog of combustible which approaches very nearly to the condition of a perfect gas from the point of view of combustion. The pulveriser, by means of which this condition is obtained, is furnished with a nozzle pierced with an orifice varying between 0.12 and 0.2 in. in diameter, according to the size of the engine. By means of it the combustible is given a speed of delivery of from 330 ft. to 500 ft. per sec. under a pressure of from 1,340 lb. to 2,000 lb. per sq.in. produced by the injection pump. In some engines, such, for example, as the Vickers, this pressure has even been taken to as high as 14,000 lb. per sq.in. without any of the fittings suffering more than do hydraulic presses, for example.

Other things being equal, the losses in these engines—consisting of heat in the exhaust gases, heat in the circulating water and radiation losses—are practically the same as in Diesel engines. But the latter have a mechanical efficiency of only 75 per cent, while the explosion engines with which I am comparing them, reach a mechanical efficiency of from 85 to 87 per cent. There is, therefore, a gain of from 10 to 12 per cent in favor of the explosion motor, and this gain is realized with a compression pressure of from 260 lb. to 340 lb. per sq.in. which means an initial explosion pressure of from 430 lb. to 500 lb. per sq.in. Assuming that the new engine with mechanical injection and moderate compression has only the same consumption as the Diesel engine, it still has the advantages of simplicity and less cost to build, which latter amounts to about 20 per cent.

Steam Turbines and Diesel Engines Applied to Locomotives

That the success of the steam turbine or the Diesel engine for locomotive practice depends not only on the possible gain in economy, but also on relation that such a type of locomotive will bear to the rest of the railroad, as influenced by the design and characteristics of the prime mover, was brought out at the meeting of the Metropolitan Section of the A. S. M. E., March 13, 1923, at New York.

The subject "The Diesel Locomotive" was discussed by Elmer A. Sperry. Prior to reading a paper on this subject Mr. Sperry gave a report of his trip made to Japan last autumn to represent, as honorary vice-president, the American Society of Mechanical Engineers at the twenty-fifth anniversary of the Japanese Society of Mechanical Engineers, and the American Society of Naval Constructors and Architects at the meeting of the Japanese Naval Society. His outline of the trip and pleasant experiences with the Japanese engineers was interesting to the large attendance. Mr. Sperry expresses the belief that in many ways the Oriental engineer is far ahead of his Western contemporary.

In his discussion on the Diesel locomotive, Mr. Sperry predicted that in the future the larger systems would use Diesel-driven locomotives to the exclusion of the present steam engine. His predictions were based on the lower fuel costs of the oil-burning unit.

One of the principal and yet unperfected details of the Diesel locomotive is the matter of drive. Since the internal-combustion engine, unlike the steam machine, has no torque at zero speed, it is impossible to drive direct. Some speed-reducing arrangement such as gear-shift, motor-generator or hydraulic gear is essential. Mr. Sperry showed plans of a hydraulic gear drive that seemed to offer some hope to the locomotive designer. Most of the speaker's time was taken up in a discussion of the advantage of the compound Diesel upon which he has been devoting considerable effort. He compared this high-speed unit weighing 30 pounds per horsepower with a slow-speed marine Diesel weighing 450 pounds per horsepower. Many felt that a better plan would have been the comparison of the compound with a modern high-speed Diesel weighing 25 pounds per horsepower.

There was a distinct feeling among the locomotive designers present at the meeting that the steam unit has so far no competitor when all the factors are considered.

Albert F. Stuebing, Mechanical Department Editor of *Railway Age*, described four types of turbine-driven locomotives which have appeared in recent years. An English locomotive, constructed in 1908, weighed 57,000 lb. and contained four turbines through which one continuous steam path was formed. These turbines contained separate nozzles and blade construction to provide for reversing. The locomotive developed 1,500 horsepower.

In 1921 the Swiss converted a reciprocating locomotive installing a Zoelly type turbine, geared with a ratio of 30 to 1 to the drivers, which was contained at the front truck. The turbine operated at 8,000 r.p.m., giving a train speed of 48½ miles an hour. A turbine-driven electrical generator which generated 890 kw. with motors had been tried in England, but was not used commercially. The Ljungstrom turbine, recently placed on a commercial locomotive in Sweden, represents an epoch in turbines for railway service. Results to date, however, are not sufficient to draw definite conclusions as to the utility of the turbine for locomotive service.

Conditions which influence the adaptability of the turbine are: The length of the rotor, which should correspond, to some extent, with the gage of the tracks, as it is ordinarily necessary to place this parallel to the axle for the purpose of gearing; inherent non-reversibility of the turbine; high speed necessary to produce the required power in the prescribed space; inability to operate at high vacuum on account of the mechanical limitations of the condensing equipment; only about two-thirds of the entire weight being available for driving, as in the Ljungstrom unit, instead of the entire weight, as in a steam locomotive.

The coal consumption of the Ljungstrom locomotive on test, appears to be one-half that of the reciprocating type. The consumption given during two runs indicates that twice as much coal per ton-mile is consumed where there are frequent stops compared to the fuel consumed on a long run with few stops. Remarks were made by C. S. Street, E. H. Thompson and W. E. Symonds.

Manufacture of Engines in 1921

The Department of Commerce announces that the manufacturers' reports to the Bureau of Census show that the sales of engines, including steam, gas and hydraulic, amounted to $199,499,000 in 1921. The gas-engine reports include only those engines and tractors produced for sale and do not include engines used in automobiles and trucks when produced by builders of those vehicles.

The classification of engine sales is interesting as showing that the total horsepower of steam engines built in 1921 was 1,983,987, of which 1,418,114 hp. were steam turbines. The total internal-combustion engines, excluding the automobile engines, tractors and farm engines, was 1,289,308 hp. Farm-engine horsepower was 1,533,006 and tractor engine sales reached 34,386 hp. The strictly oil-engine output, including Diesel and semi-Diesel units, was, as near as can be determined from the report, around 150,000 hp. Gas engines show the surprising total of 571,328 hp., of which four units were over 5,000 hp. each and ten over 1,000 horsepower.

Production of Rustless Iron

There has been developed recently in England a "rustless iron." This material is iron to which a certain proportion of chromium has been added. A similar alloy called "stainless steel" has for some time been familiar to metallurgists. Stainless steel differs from rustless iron chiefly in that it contains small amounts of carbon.

In order to produce rustless iron, an iron-chromium alloy free from carbon, it is necessary that carbon-free iron and chromium be available. The usual forms of chromium, commercial grades of ferro-chromium, contain comparatively large amounts of carbon. The discovery of rustless iron has thus made it very important to be able to treat ferro-chromium by some process which will remove the carbon. Among the methods proposed is that of heating ferro-chromium in contact with hydrogen.—*The Valve World.*

Engineers Discuss Water Power for Metropolis

The proposal to transmit power to the New York metropolitan district from the Niagara, the St. Lawrence, Hudson, Delaware and Susquehanna rivers is not a new one, but is just now the subject of lively interest and much newspaper discussion. For this reason the recent broad consideration of the question in a combined meeting of four great engineering societies was most timely and was in line with the growing interest and influence of the engineering profession in public affairs. This meeting, which was held in the Engineering Societies Building in New York City on March 21, was attended by approximately 800 members of the A.S.C.E., A.I.M.E., A.S.M.E. and the A.I.E.E., as well as many representatives of the non-technical public.

The program was in the form of a symposium in which engineers prominent in one or more of the main divisions (steam, hydraulic and electrical) of power work discussed the subject from various angles in 20-minute talks. An extensive report of this meeting will appear in next week's *Power*, so it will suffice here to mention briefly some of the main points brought out.

It devolved upon the first speaker, F. W. Scheidenhelm, consulting engineer, to make the preliminary co-ordinating statement of the problem. After defining the metropolitan district as embracing New York City, Westchester County (N. Y.) and northeastern New Jersey, he said it was generally agreed that this populous region would sooner or later supplement its steam power to some extent with hydro-electric energy. The following five obstacles were, however, enumerated: (1) Limited extent to which hydro-electric power could be supplied in comparison with the total power requirements of the region; (2) uncertainty as to the relative costs of steam power and water power; (3) doubts as to quality of service; (4) legal difficulties; (5) lack of a definite and continuous state and national policy. Mr. Scheidenhelm then considered the first three points in detail in relation to the various proposals and followed it with an outline of the economic and engineering problems involved.

The next speaker, W. S. Murray, consulting engineer and formerly chairman of the Superpower Survey, was fittingly assigned the subject, "An Approximation of Available Water Power and Cost of Delivery." He emphasized the importance of interconnection in accordance with the general scheme laid down by the super-power report, and then showed how the various available streams presented fundamentally different engineering problems according to their location and general characteristics. He pointed out that the hydro-electric power available for the metropolitan district in 1930 would meet only a small fraction of the requirements, the remainder being necessarily supplied by steam.

The next speaker, George A. Orrok, consulting engineer for the New York Edison and affiliated companies, spoke on the requirements of service and the evaluation of hydro-electric power. While emphasizing the advantages of locally generated steam power over long-distance hydro-electric power from the viewpoint of reliability of service and delivered cost, he admitted that the great improvement in transmission lines and the increasing cost of coal might soon make it desirable to supplement steam power with all available water power. He warned against underestimating the delivered cost of water power, saying that the exacting service requirements of the metropolitan district would make it necessary to provide duplicate transmission lines and steam stand-by.

A detailed study of hydro-electric plants, and particularly of the Holtwood Plant on the Susquehanna River, from the viewpoint of possible service interruptions, was presented by F. A. Allner, general superintendent of the Pennsylvania Water & Power Co. This paper, exhibiting a close acquaintance with operating problems, showed that the few remaining difficulties due to anchor ice and other natural phenomena were being rapidly overcome.

The last speaker was Lorin E. Imlay, consulting engineer for the Niagara Falls Power Co. Mr. Imlay, whose subject was "The Reliability of Long-Distance Transmission," insisted that transmission lines had now developed to such a degree of perfection that long-distance power lines could handle the most exacting service without local stand-by capacity. As evidence he cited Syracuse, Buffalo and several Canadian cities. The latter in particular, he said, were entirely satisfied with the service.

The papers were discussed by John P. Hogan, consulting engineer, and W. S. Findlay, Jr., vice-president of the American Water Works & Electric Co.

Japanese Electric Company Orders Power Apparatus

The Daido Power Co., which operates one of the largest electric power systems in Japan and which is making important extensions in its system, has ordered from the Westinghouse Electric & Manufacturing Co., two large self-starting synchronous condensers to be used for voltage control at its Rokugo substation in the City of Nagoya. The condensers are 10,000 kva. 0 per cent power factor leading, 7,500 kva. 0 per cent power factor lagging, 11,000-volt, 60-cycle, 720-r.p.m. 10-pole machines. Each will be provided with an 80-kw. 125-volt direct-connected exciter and with a 3,300-volt wound-rotor type starting motor which can be used for driving the condenser as a generator for testing out the transmission line.

This company is an amalgamation of a number of power companies. At present its lines are used principally for furnishing power to Nagoya and Osaka. The total generating station capacity including extensions contemplated within the next ten years, amounts to 640,000 kw., and the receiving stations will have a total installed capacity of 560,000 kw. All the Daido lines transmitting power to Nagoya and Osaka are for 60-cycle service, while those that are proposed for transmitting to the City of Tokyo will be for 50 cycles. Some of the proposed generating stations, therefore, will be able to supply either 50- or 60-cycle service, and to supply the two frequencies, certain generating stations are provided with waterwheels and generators suitable for operating at two speeds having a ratio of 5 to 6. It is probable that connections from the Daido lines will be made to the system of the Tokyo Electric Light Co. and that tie connections will be made to the Imperial Government Railways transmission system. At Osaka parallel connections are now made to steam plants of the Osaka Electric Light Co., which contain approximately 125,000 kva. in turbine generators.

The contemplated development of the Daido company, which will be carried out at 154,000 volts in accordance with the plans of the Imperial Japanese Government for the development of a Japanese superpower system, will constitute a system of considerable magnitude, particularly in view of the fact that the 154,000-volt lines of the Tokyo Electric Lighting Co. and its various subsidiaries will doubtless be connected with the Daido lines.

Broken Belt Causes Flywheel Explosion

On Tuesday, March 20, a flywheel explosion occurred at the power plant of the Consolidated Gas Company located at Eleventh Street and Avenue D, New York City. The engine was of the horizontal type and fitted with a riding-cut-off piston valve. It was used to drive a blower through a belt. The packing ring on the cut-off valve was found broken for a length of about 3 in. This had evidently been broken for some time but, in the opinion of the engineers of the company had nothing to do with the accident.

The theory that the initial cause of the accident was the breaking of the belt was strengthened by the fact that the recording gage on the blower showed no building up of pressure but instead a sudden drop. Two men were slightly injured and the steam pipe was broken, but little damage was done to the building. Apart from the loss of the flywheel and a slight bending of the main shaft, the engine remained intact.

News in the Field of Power

Undeveloped Water Power in New York State

According to the report of the New York Water Power Commission for the year ending Dec. 31, 1922, there is 3,424,712 hp. available within the state with 2,392,694 hp. of it listed as undeveloped. The accompanying map shows in watershed sections where this undeveloped water resource is located. Applications covering a large amount of this undeveloped power have been filed with the Commission.

Although the diversion for power purposes to the United States under the Burton Act is 20,000 cu.-ft.-sec., or 600,000 hp. at Niagara, only 300,000 is listed as being utilized in 1922. Installations, however, of three 70,000-hp. units, now being installed to more efficiently utilize the water and discontinuing the use of some old equipment, will bring this figure up to 450,000 hp. by the end of the year.

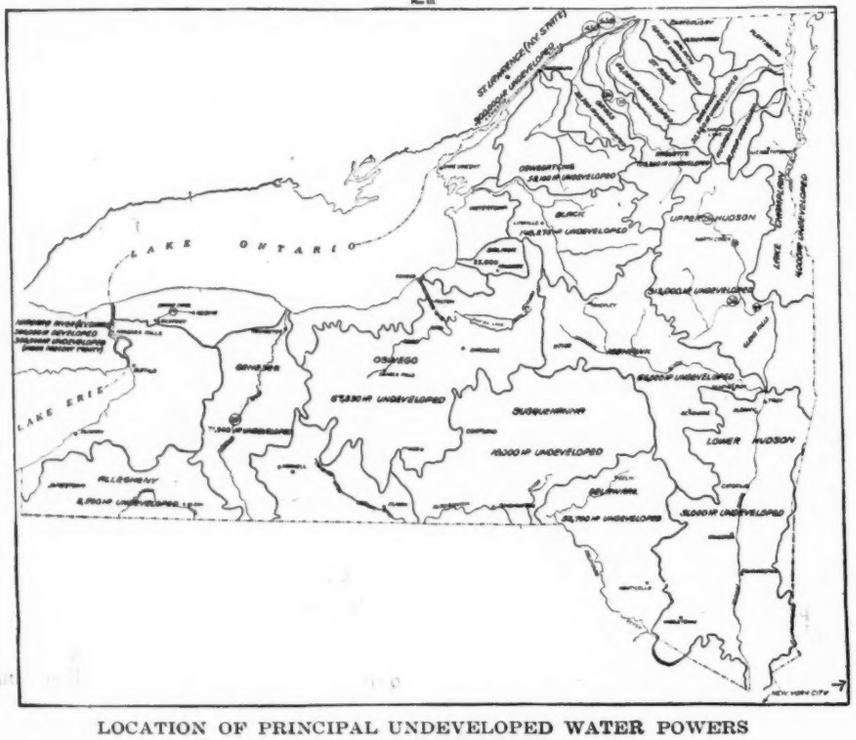
There is evidence that as soon as additional diversion is provided for under a new treaty with Canada, projects will be applied for to develop additional power at Niagara Falls.

In fact, several companies have asked permission to make application for power projects involving waters in addition to the amount permitted to be diverted which have been denied.

Governor Smith Asks Appropriation to Finish Power Plants

Governor Smith in a special message to the Legislature on March 19, asked for the immediate appropriation of $740,000 to complete the hydro-electric power development from the surplus waters of the barge canal at Vischer's Ferry and Crescent Dam, with authorization for negotiations for auxiliary steam power. This project, the first step in hydro-electric development under the state auspices, was started under Governor Miller with an appropriation of $1,000,000, which at that time was considered insufficient for the purpose.

The Governor also recommended an amendment to the law under which the project was started to authorize the superintendent of public works, the state engineer and the attorney general to negotiate with the municipalities of the Capitol district for the delivery of power to the municipalities at cost to the state for ultimate delivery to consumers. If the Governor's recommendation should be adopted, Albany, Schenectady, Cohoes, Troy, Watervliet, Rensselaer and other municipalities would be able to buy their electric power from the state.



LOCATION OF PRINCIPAL UNDEVELOPED WATER POWERS IN NEW YORK STATE
Based on map prepared by State Engineer and New York Water Power Commission.

Smoke Abatement Work Hampered by Lack of Funds

The Bureau of Mines will not be able to carry on much of its smoke-abatement work in the approaching fiscal year because of insufficient appropriations. The various committees throughout the country, however, who are directing inquiries to the Bureau regarding their smoke problems, will be furnished advice and information based on the data at hand.

While the co-operation which the Bureau will be able to give communities in this work by sending investigators to the scene will be limited, the Bureau will issue in pamphlet form the results of recent experiments which will prove helpful to those interested in smoke abatement. The subject has a new interest for many communities in the East, as they have encountered the problem more sharply during this winter than ever before on account of the increased use of bituminous coal as a substitute for anthracite.

The Bureau is also preparing a report on the results of tests at a power plant connected with a government building in Washington, D. C., which will show a remarkable difference in the cost of fuel and in the amount of smoke created by different shifts of firemen, again tracing the main cause of the smoke nuisance and high fuel costs to lack of proper instruction of personnel. This report will not be available for several months.

Seeks Information on Causes of Strikes

Additional funds and new teeth in its organic act have speeded up the work at the offices of the President's Coal Commission. The force has grown from 174 to 216 in two weeks. Field inspectors have been dispatched to each of the mining districts to gather information on causes of strikes. This work, which is under the direction of Dr. Joseph H. Willits, will be expedited particularly in the anthracite region.

Despite the uncertainty, which resulted from the delay in securing legislation, the work on production costs and on waste in mining is actually ahead of the rather ambitious schedule which was prepared when the Commission mapped out its work.

Returns to the Commission on the gross margins of wholesalers show baffling discrepancies between different cities and different parts of the country. In some instances the gross margins in 1922 were no greater than those in 1921. In other cases wholesalers doubled their margins in 1922.

Patents Issued on Lopulco Systems

Two patents, Nos. 1,441,721 and 1,441,703, have recently been issued on the 'Lopulco systems for burning pulverized fuel, the former to Virginius Z. Caracristi and the latter to John E. Muhlfeld and Virginius Z. Caracristi. These patents are controlled by the Combustion Engineering Corporation, New York.

The former patent relates to and broadly covers the burning of pulverized coal and blast-furnace gas or similar combustible in such a manner that the gas is subjected to the regenerative action of the coal particles and effectively burned, the arrangement of the flame of the pulverized fuel and air in combination with the gas flame being such that the gas must be forced into and through the current of pulverized fuel. As the mixing takes place the incandescent particles of coal become surrounded by a molecular mixture of the combustibles of the gas and oxygen, sufficient air being fed in connection with the gas to support the combustion and innumerable combustion zones are therefore created within the furnace, causing a complete combustion and maximum heating effect from both the coal and gas.

The latter patent relates particularly to boiler installations and appears to cover broadly the idea of introducing the pulverized fuel downwardly into the furnace chamber with the admission of lower-velocity bordering air for combustion under such conditions that the fuel and flames describe a U-shaped course through the chamber to the outlet, under the action of the draft.

Washington State Urges Delay of Flathead Lake Project

Officials of the State of Washington are urging the Federal Power Commission to take no action on the application of the Rocky Mountain Power Company project, which involves the development of 270,000 hp. at the outlet of Flathead Lake, until the Survey of the Columbia Basin project recently authorized by Congress is complete and action taken by Congress on the report.

The state officials contend that the State of Washington has made a detailed study of the problem extending over a period of six years, laying stress on the findings of Gen. Goethals, who had been engaged to report on the subject.

The Commission authorized by Congress to study the Columbia Basin project will consist of two members, the Secretary of the Interior announced. Francis M. Goodwin, the Assistant Secretary of the Interior, is to be the chairman of the Commission, with Arthur P. Davis, Director of the Reclamation Service, as the other member. Homer J. Galt, of the Reclamation Service, has been chosen to take charge of the field work. Other engineers of the Reclamation Service will be detailed to assist him. The geological features will be studied by a representative of the Geological Survey, while the soil examination will be made by specialists from the Department of Agriculture.

To Survey New England Power Situation

Charles T. Main has been made chairman of a committee appointed by The Associated Industries of Massachusetts to make a survey of the power situation in New England. Other members of the committee are: Prof. D. C. Jackson, of Massachusetts Tech.; H. I. Harriman, president of the New England Power Co.; B. C. Clark, vice-president of the Plymouth Cordage Co.; and G. L. Finch, of the Hood Rubber Co.

The points to be studied and reported upon are: The kinds and amounts of power in use, the cost of each, and the increase of these costs in the last ten years. New sources of power will also be investigated. The undertaking will be financed by private subscription of the members of the association.

It is reported that, because of the success attending the utilization of the water power of the Selune River in the Department of the Manche, France, the French company in charge of that work has planned a second and much larger plant to take care of the increased demand for electric power in this district. The plans involve the construction of a dam for a lake reservoir and a power station.

New Publications

Power Stations. By Thomas Edward Murray, LL.D., D.Sc., past president Association of Edison Illuminating Companies, member American Society of Mechanical Engineers, Fellow American Institute of Electrical Engineers. Cloth; 6 x 9 in.; 178 pages; illustrated.

Mr. Murray is one of those who, entering the electrical field in its beginning, has watched the progress of the electric plant from its small and simple stages to the modern superpower station, for the design and construction of many of which he and his organization are responsible. As John W. Lieb says, in the preface of the book before us: "The problems that presented themselves were largely questions of design and application for which there was no precedent and no experience to point the way. Now all these things have changed. The mechanical and electrical apparatus has become more or less standardized, and the building of a large power plant is principally a matter of the economical arrangement of the equipment, the development of the structural design and the carrying out of the building and installation operation with the utmost efficiency in the utilization of labor and material."

This volume is presented as a supplement to the book which Mr. Murray produced in 1910 upon Electric Power Plants, and makes available in convenient and concise form some of the more important data relating to the design of several modern steam and hydro-electric stations that have been erected under the author's supervision. It contains portraits of Thomas A. Edison and Anthony Nichols Brady, reproductions of photographs and drawings of recent stations, together with statements of their principal features and proportions.

Obituary

Edward H. Dean, president of the Dean Brothers Pump works, died suddenly at his home in Indianapolis on Sunday night, March 11, after an illness of a few hours. Mr. Dean was born at Deansboro, N. Y., in 1843. When he was seven years old, his family moved to New York City and he attended the public schools of Brooklyn, N. Y. He afterward learned the machinists' trade and in the Civil War served three years in the United States Navy as engineer. He served on the flagship "Minnesota" and later on one of the new Ericsson monitors. While on duty on the Minnesota, he took part in the bombardment of Ft. Fisher. After the Civil War Mr. Dean entered the foundry and machine business at Rome, N. Y., and in 1870 this business was moved to Indianapolis. For more than 50 years Mr. Dean has been president of the Dean Brothers Steam Pump Works.

Personal Mention

R. H. Beaumont Co., Philadelphia is appointing P. K. Reed as manager of its Chicago office, 760 Monadnock Block, Chicago, Ill.

L. H. Morrison was recently elected secretary of the Gas Power Division of the A.S.M.E. His activity in this field of work will make his services very valuable.

J. Rowland Bibbins, formerly manager of the United States Chamber of Commerce, announces the establishment by him of a new office as consulting engineer at 921 Fifteenth St., Washington, D. C.

B. F. Wood has severed his connection with Wood, Hulse, Yates Co., and has formed a company of his own under the name of Wood, Piggott & Stevens, consulting engineers, New York City.

H. P. Sleeper, formerly of the Supply Engineering Dept., Westinghouse Electric and Manufacturing Co., has entered the employ of the Duquesne Light Co., Pittsburgh. Mr. Sleeper will handle the protective work of the light company.

B. Olney Hough, for many years editor of the *American Exporter*, has relinquished that position to establish himself as expert counsellor, consultant and adviser to banks, exporters and manufacturers, with offices at 17 Battery Place, New York City.

Society Affairs

The Seattle, Wash. Section, A.I.E.E. will hold a meeting on April 18, 1923, at which Willis T. Batcheller will speak on "The Columbia Basin Project."

The Baltimore Section, A.I.E.E., R. T. Greer, acting secretary, will hold a meeting on April 20, 1923. H. K. Hawley will give a paper on "Insulator Design and Manufacture."

The Washington, D. C. Section, A.I.E.E., Roland Whitehurst, 1823 L St. N. W., Washington, D. C., will hold a meeting on April 10. Stephen Q. Hayes, consulting engineer for the Japanese government, will speak on "Japanese Power Development."

The **Providence (R. I.) Section of the A.S.M.E. and A.I.E.E.,** with the cooperation of the Providence Engineering Society, Providence Safety Council, Pawtucket Safety Council, Woonsocket Chamber of Commerce Committee on Public Safety, will hold a joint meeting at Memorial Hall, Providence, R. I., April 6, 1923, at 8 p.m. The subject will be Engineering Phases of Accident Prevention." Charles B. Scott, manager of the Bureau of Safety, Chicago, Ill., will speak on "The Engineer—an Apostle of Safety," and Lewis McBrayne, general manager of the Massachusetts Bureau of Safety Council, on "The Engineer as a Factor in Community Safety."

The **A.I.E.E.** announces the report of the Committee of Tellers of its canvass of the nomination ballots cast for candidates for offices falling vacant July 31, 1923, as follows: President, Harris J. Ryan, Stanford University, Calif.; vice-presidents, District No. 2 (Middle Eastern) William F. James, Philadelphia, Pa.; No. 4 (Southern) H. E. Bussey, Atlanta, Ga.; No. 6 (North Central) Herbert S. Sands, Denver, Colo.; No. 8 (Pacific) J. E. Macdonald, Los Angeles, Calif.; No. 10 (Canada) S. E. M. Henderson, Toronto, Ont. For managers; H. P. Charlesworth, New York City, William M. McConahey, Pittsburgh, Pa., W. K. Vanderpoel, Newark, N. J. For treasurer, George A. Hamilton, Elizabeth, N. J.

Business Notes

Charter Gas Engine Co., Sterling, Ill., announces the purchase of the August Mietz Corp., of New York City, manufacturer of the Mietz & Weiss and Mietz Semi-Diesel oil engine.

Hiram Rivitz Co., one of the large jobbing houses of Cleveland, Ohio, has recently passed into the hands of the Walworth Ohio Co., a subsidiary of the Walworth Manufacturing Co., Boston.

Chicago Pneumatic Tool Co., New York City, has appointed H. J. Bradley, branch manager at San Francisco, succeeding J. K. Haigh, who has been transferred to the Chicago branch to resume sales work.

The Cambridge and Paul Instrument Co., of America, Inc., was recently incorporated in New York to handle in the United States the industrial and scientific instruments made by the Cambridge & Paul Instrument Co., of Cambridge and London, England. The general office and works are situated at Ossining, N. Y., and the New York City sales office and showroom are in the Grand Central Terminal, New York City.

Coming Meetings

American Society of Mechanical Engineers, 29 W. 39th St., New York City. Pacific coast regional meeting at Los Angeles, April 16-18; Spring meeting at Montreal, Canada, May 28-31.

Affiliated Technical Societies of Boston, 715 Tremont Temple, Boston, Mass. Meeting at Lorimer Hall, Tremont Temple, 7:45 p.m., March 28. Topic, Fuel and Power Problems.

American Chemical Society, Gas and Fuel Section; R. S. McBride, Colorado Bldg., Washington, D. C. Motor fuel symposium at New Haven, Conn., April 6.

Society of Industrial Engineers; George C. Dent, 327 S. La Salle St., Chicago, Ill. Spring convention at Cincinnati, Ohio, April 18-20.

American Institute of Electrical Engineers; F. L. Hutchinson, 29 West 39th St., New York City. Spring meeting at Pittsburgh, Pa., April 24-26.

American Welding Society, 29 W. 39th St., New York City. Annual meeting at New York City, April 27-28.

American Society of Refrigerating Engineers; W. H. Ross, 154 Nassau St., New York City. Spring meeting at St. Louis, Mo., April 30, May 1-2.

American Association of Engineers; C. E. Drayer, 63 East Adams St., Chicago, Ill. Annual convention at Norfolk, Va., May 7-9.

National Association of Manufacturers; George S. Boudinot, 50 Church St., New York City. Annual conference, New York City, May 14-16.

American Water Works Association, 163 W. 71st St., New York City. Annual meeting at Detroit, Mich., May 21-25.

Stoker Manufacturers' Association; J. G. Worker, Eau Claire, Wis. Annual convention at Lake Placid Club, Essex Co., N. Y., May 29-31.

American Boiler Manufacturers Association; H. N. Covell, 191 Dikeman St., Brooklyn, N. Y. Thirty-fifth Annual Convention at Hot Springs, Va., June 4-6.

National Electric Light Association; M. H. Aylesworth, 29 West 39th St., New York City. Annual meeting at New York City, June 4-8.

American Order of Steam Engineers; W. J. Brice, 1428 Callowhill St., Philadelphia, Pa. Annual convention at Philadelphia, June 4-8.

Electric Power Club; S. N. Clarkson, Kirby Bldg., Cleveland, Ohio. Annual meeting at Hot Springs, Va., June 11-14.

National Association of Stationary Engineers; Fred W. Raven, 417 South Dearborn St., Chicago, Ill. Annual convention and exhibition at Buffalo, N. Y., Sept. 10-15. Annual conventions and exhibitions of the State Associations scheduled as follows:

Kansas, at Fort Scott, April 4-6; C. H. Taylor, 517½ W. 6th St., Topeka.

Indiana, at La Fayette, Ind., May 28-29; T. J. Kelly, 2704 South St., La Fayette, Ind.

New Jersey, at Trenton, N. J., June 1-3; Samuel Clark, 67 Columbia St., Jersey City, N. J.

Illinois, at Springfield, Ohio, June 6-9; F. W. Raven, 417 South Dearborn St., Chicago.

Trade Catalogs

Steam Vessels—National Boiler and General Insurance Co., Limited, Manchester, **Eng.** Under this title are published some notes on the design, construction and working of vessels subject to steam pressure.

Equipment in a Textile Mill—De Laval Steam Turbine Co., Trenton, N. J. Leaflet E1051 describes a turbine which utilizes exhaust steam for heating and process purposes, or the production of power as a byproduct from steam used at low pressures.

Boilers—Oil City Boiler Works, Oil City, Pa. Catalog H-9 describes the company's steel firebox boilers for steam and hot-water heating. Useful tables of service pipe capacities in square foot of radiation, co-efficients of heat transmission in buildings and temperatures used in heating determinations are included.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Mar. 12, 1923	Mar. 19, 1923
Pool 1,	New York	$4.25–4.75	$4.00–4.75
Smokeless,	Columbus	4.25–4.75	4.25–4.75
Clearfield,	Boston	2.85–3.75	2.65–3.50
Somerset,	Boston	3.25–4.00	3.00–3.75
Kanawha,	Columbus	2.50–2.75	2.50–2.75
Hocking,	Columbus	2.35–2.50	2.25–2.50
Pittsburgh No. 8	Cleveland	2.85–3.00	2.65–2.75
Franklin, Ill.,	Chicago	3.25–3.50	3.25–3.50
Central, Ill.,	Chicago	2.50–2.75	2.50–2.75
Ind. 4th Vein,	Chicago	2.75–3.00	2.75–3.00
West Ky.,	Louisville	1.85–2.15	1.75–2.00
S. E. Ky,	Louisville	2.25–3.00	2.50–3.00
Big Seam,	Birmingham	2.00–2.25	.....

FUEL OIL

(f.o.b. city unless otherwise specified)

New York—March 22, Port Arthur light oil, 22@25 deg. Baumé, 5½c. per gal.; 30@35 deg., 5½c. per gal., f.o.b. Bayonne, N. J.

Chicago—March 3, 24@26 deg. Baumé, $2.02 per bbl.; 32@36 deg., $2.39 per bbl. in tank cars.

Philadelphia—March 19, 26@28 deg. Baumé, Oklahoma,, $1.05@$1.10 per bbl.; 30@34 deg., Oklahoma (group 3), 3¼@3⅜c. per gal.; 16@20 deg. Seaboard, $1.50@$1.60 per bbl.

St. Louis—March 22, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.95 per bbl.; 26@28 deg., $2.05 per bbl.; 28@30 deg., $2.15 per bbl.; 32@36 deg., gas oil, 5¼c. per gal.; 36@40 deg., distillate, 5⅜c. per gal.

Pittsburgh—March 12, f.o.b. local refinery, 30@34 deg., fuel oil, 6½c. per gal.; 36@40 deg., fuel oil, 6⅜c. per gal.; 34 deg., neutral, 10c. per gal.

Dallas—March 17, f.o.b. local refinery, 26@30 deg., $1.50 per bbl.

Cincinnati—Feb. 27, 26@28 deg. Baumé, 5⅜c. per gal.; 28@30 deg., 5⅜c. per gal.; 38@40 deg., distillate, 7c. per gal.

Cleveland—Feb. 27, 26@28 deg., Baumé, 6⅜c. per gal.

New Plant Construction

PROPOSED WORK

Ala., Birmingham—J. Black & Sons, 3rd Ave., have purchased site and plan to build a 7 to 10 story, 140 x 150 ft. department store on 4th Ave. and 19th St. Estimated cost $1,000,000. Engineer or architect not selected.

Ala., Birmingham—The Southern Amusement Co., Dallas, Tex., plans to build an 8 to 12 story, 150 x 190 ft. hotel and vaudeville theatre building for Loew's circuit, on 5th and 19th Sts. Estimated cost $1,500,000. Engineer or architect not announced.

Ala., Florence—The Dist. Engr., United States Engineer Office, is receiving bids until Apr. 3 for furnishing head-gate track, screen track, sea castings, vent outlet castings, with bell-mouth castings, etc., for the power house section of Wilson Dam.

Ark., Helena—The White River Drainage Dist. is having plans prepared for the drainage of 160,000 acres in Phillips, Desha and Monroe Counties; construction of levees, dams, ditches, etc.; pumping units and pump. Estimated cost $4,500,000. G. E. Blackburn, Millwood, O. D. Howell, Wabash and W. W. Meacham, Snow Lake, Comrs. Harrington, Howard & Ash, Orear-Leslie Bldg., Kansas City, Mo., Engrs.

Calif., Clarksburg—S. C. Davidson, Engr., Box 925, Sacramento, will soon receive bids for the construction of a pumping plant, including 8 or 10 in. pumps and motors to be used in connection with small irrigation project, about 1,250 acres, here, for the C. C. Morse Seed Co., 729 Front St., San Francisco. Noted Mar. 13.

Calif., Los Angeles—The county, L. E. Lampton, County Clk., will receive bids until Apr. 2 for furnishing and installing a steam driven electric generator, complete with all piping and control equipment, in the county hospital.

Calif., Los Angeles—S. Gerson, 549 Mission Rd., (boiler shop) is in the market for a 15 hp. upright boiler.

Calif., Los Angeles—C. Morris, c/o Walker & Eisen, Archts., Finance Bldg., is having plans prepared for the construction of a 13 story apartment building on Catalina and Wilshire Sts. Cost will exceed $1,000,000. Equipment detail not reported.

Calif., Petaluma—The Petaluma Municipal Water Dist. will vote on a $750,000 bond issue for the construction of a water supply system, including storage dam, two diversion dams, pipe lines, flumes, canals, filtration plant, distributing system, etc. Howe & Peters, 24 California St., San Francisco, and C. G. Hyde, 2575 Buena Vista Ave., Berkeley, Engrs.

Calif., San Diego—J. J. Cantwell, Roman Catholic Archbishop, Higgins Bldg., Los Angeles, plans to build a hospital to contain more than 175 beds, here. Cost will exceed $250,000. Engineer or architect not announced.

Calif., San Francisco—A. Abrams, 2151 Sacramento St., is having plans prepared for the construction of a 9 story, 56 x 137 ft. hospital building on Sutter near Larkin Sts. Estimated cost $500,000. M. I. Schwartz, Nevada Bank Bldg., San Francisco, Archt. Equipment detail not reported.

Cal., Yuba City—The city, C. C. Kline, City Clk., will receive bids until April 2, for the construction of a sanitary sewer system consisting of (1) furnishing materials and constructing pumping plant, including equipment; (2) furnishing and laying approximately 10,500 ft. pipe and installing flushers, manholes and lamp-holes. Estimated cost $50,000. E. Von Geldern, Engr.

Colo., Grand Junction—The Grand Junction Electric Co. plans to build a power house. Estimated cost $22,000.

D. C., Wash.—The city plans to build a filtration plant, including pumping station at the District line beyond Georgetown. Estimated cost $2,000,000. M. C. Tyler, U. S. Engineer's Office, Old Land Office Bldg., Engr.

D. C., Wash.—Hecht & Co., 7th and F Sts., are having plans prepared for the construction of an addition to department store. Estimated cost $2,000,000. J. Hunt, 30 North Michigan Ave., Chicago, Archt. Equipment detail not reported.

D. C., Wash.—The Thompson Dairy Co., Southern Bldg., plans the construction of a power plant at 2012 11th St., N.W. Estimated cost $25,000. Col. P. M. Anderson, Engr., will purchase equipment, including one 16 and one 23 ton refrigerating apparatus, one 333 kw. motor generator set and two 40 hp. boilers for owners.

Idaho, Grangeville — The Grangeville Electric Light & Power Co. has secured water rights and is having surveys made for the construction of a dam on the North Fork of the Clearwater River and the installation of a 4,000 hp. hydro electric plant with transmission lines to Orofino.

Ill., Blue Island—The Federal Refrigerating Co., c/o City Ice & Fuel Co., Cadillac Bldg., Cleveland, Ohio, H. D. Norval, Pres., will receive bids until Mar. 28 for the construction of a 1 story, 101 x 123 ft. ice storage plant, here. Estimated cost $150,000. C. C. Coneby, Cadillac Bldg., Cleveland, Ohio, Engr. and Archt.

Ill., Chicago—The Barber Asphalt Co., Tribune Bldg., is in the market for a steam drive generator, 300 kw., 110 volt d.c.; 4 valve Corliss type engine.

Ill., Chicago — The Washington Gas & Electric Co., 2031 Peoples Gas Bldg., is in the market for coal and ash handling equipment for power house at Washington Court House, Ohio.

Ill., Springfield—The city has had plans prepared and will soon receive bids for the construction of a settling basin, 5,000,000 gal. cap. and a turbine centrifugal pump, 10,000,000 cap. Burns & McDonnell, 4th floor, Interstate Bldg., Kansas City, Mo., Engrs.

Kan., Smith Center — The city, C. S. Sargent, Clk., will receive bids until March 30, for (1) the construction of a 500,000 g.p.d. filtration plant with the necessary settling basins, and 200,000 gal. clear well connection to present city mains, low service pumping station and intake in Solomon River, and force main from Solomon River to Smith Center; (2) the furnishing and installing of the necessary filter equipment for the 9 x 10 ft. filter units. Black & Veatch, Mutual Bldg., Kansas City, Mo., Engrs.

Ky., Carter—The Ashland Limestone Co. plans to build a power house. Estimated cost $60,000.

La., New Orleans—The Sewerage & Water Bd., A. G. Moffat, Secy., G. G. Earl, Genl. Supt., will receive bids until Apr. 26 for 1,500-1,800 hp. water tube boilers.

Mass., East Braintree (Boston P. O.)—The East Braintree Bleachery & Dye Wks. will soon award the contract for the construction of a 3 story, 53 x 55 ft. addition to plant, including steam heating system, and a 1 story, 20 x 22 ft. power house on Adams St. Estimated cost $40,000. Private plans.

Mich., Detroit — The Aubin Terminals Corp., 707 Free Press Bldg., is having plans prepared for the construction of an 8 story, 195 x 389 ft. warehouse to handle automobile shipments, including dock and wharf, on West Jefferson Ave. and West Grand Blvd. Estimated cost $3,000,000. G. M. Hopkinson, 5716 Euclid Ave., Cleveland, Ohio, Engr. The engineer is in the market for conveying equipment.

Mich., Detroit—The Children's Hospital, Farnsworth Ave., is having plans prepared for the construction of a 5 story, 150 x 225 ft. nurses' home, including 2-pipe vacuum steam heating system with boilers, stokers, ash hoist, stoker blower, two horizontal tube boilers, 1,250 sq.ft. heating surface, pressure 100 lbs. per sq.in. A. Kahn, 1000 Marquette Bldg., Detroit, Archt.

Mich., Detroit—The Elks, Detroit Lodge No. 34, Lafayette Blvd. and Case Ave., are having plans prepared for the construction of a 10 story, 60 x 145 ft. temple and club house to contain dormitories, swimming pool and gymnasium, including steam heating sytem. Architect's name withheld.

Mich., Grand Rapids—F. Hollingsworth, 18 Monroe St., representing owner, is having plans prepared for the construction of a 3 story apartment building, to contain 500 apartments, on Fisk Lake. Estimated cost $6,000,000. Ohrenstein & Hill, 232 Erie St., Chicago, Archts. Equipment detail not reported.

Mich., South Haven—L. A. Shnaper is having sketches prepared for the construction of a 6 story hotel on Phoenix St. Estimated cost $300,000. Nichol, Schater & Hoffman, Lafayette, Archts.

Mo., Trenton—The Bd. of Public Wks. will receive bids until Apr. 5 for (a) furnishing materials and constructing river intake, low service pump stations, settling basins, head house, filter house and high service pump station, four filter units (three equipped) each 500,000 gal. capacity, clear water reservoir and installing switchboard and pumping equipment; (b) furnishing F.O.B. cars Trenton, about 360 ton of Bell & Spigot cast iron pipe and specials; (c) about 25 steamer hydrants and 47 gate valves, 4 to 12 in.; (d) switchboard and seven horizontal motor driven pumps, consisting of two low service pumps (700 and 1,400 g.p.m.), reservoir low service pump (1,000 g.p.m.), wash water pump (2,700 g.p.m.) and three high service pumps (700, 1,000 and 1,400 g.p.m.). Estimated cost $175,000. Burns & McDonnell, Interstate Bldg., Kansas City, Engrs.

N. Y., Bayside—The Bd. Educ., 500 Park Ave., New York, is having plans prepared for the construction of an addition to Public School 41, including steam heating system, here. Estimated cost $500,000. W. H. Gompert, Flatbush Ave. Extension and Concord St., Brooklyn, Engr. and Archt.

N. Y., Brooklyn — The Bd. Educ., 500 Park Ave., New York, is having plans prepared for the construction of a school building, including steam heating system (Public School 210), near Park Pl. and Rochester Ave., here. Estimated cost $700,000. W. H. Gompert, Flatbush Ave. Extension and Concord St., Brooklyn, Engrs. and Archts.

N. Y., Brooklyn—The Wheeler Salvage Co., 224 Bush St., Brooklyn, is in the market for a 100 lb. steam driven compressor.

N. Y., Elmira—M. Chambers, 30 Lincoln St., is in the market for a return flue boiler, 10 hp. or larger.

N. Y., Jamaica — The Bd. Educ., 500 Park Ave., New York, is having plans prepared for the construction of a school building, including steam heating system (Public School 214), on Conduit Ave., here. Estimated cost $700,000. W. H. Gompert, Flatbush Ave. Extension and Concord St., Brooklyn, Archt.

N. Y., Jamaica — The Bd. Educ., 500 Park Ave., New York, is having sketches made for the construction of a school building, including steam heating system (Public School 116), on Wren Pl., here. Estimated cost $750,000. W. H. Gompert, Flatbush Ave. Extension and Concord St., Brooklyn, Archt.

N. Y., Nunda—Peck & Pratt, Inc. (condensery), in the market for complete ammonia cold storage system.

N. Y., Phelps — District 4 will hold an election Apr. 2 to vote on a $20,000 bond issue for a new steam heating plant in school.

N. Y., Watertown—J. W. Ackerman, City Mgr. and P. B. Sutton, City Engr., will receive bids for three vertical turbines to drive three 2,250 hp. generators. Estimated cost $1,000.

Ohio, Toledo—The Home Savings Bank Co., Gardner Bldg., will soon award the contract for the construction of a 9 story, 59 x 119 ft. bank and office building on Madison and Huron Sts. Estimated cost $1,000,000. Walker & Weeks, 1900 Euclid Ave., Cleveland, Archts. Equipment detail not reported. Noted Dec. 12.

Okla., Ardmore—The Colvert Ice Co., Inc., is having plans prepared for the construction of a 2 story, 60 x 110 ft. ice plant. Estimated cost $50,000. J. White, 101 West Main St., Ardmore, Archt. The owner is in the market for refrigeration machinery and equipment.

Okla., Tonkawa—The city voted a bond issue for the construction of a 1 story, 50 x 70 ft., 500 hp. oil engine power plant, including machinery and wiring, on 4th and Oteo Sts. Estimated cost $70,000. Ruchel Eng. Co., Interurban Bldg., Hutchinson, Kan., Engrs.

Ore., Portland—P. Lind, Archt., 208 Artisan Bldg., will receive bids about May 1 for the construction of a 12 story, 145 x 169 ft. residential hotel building and a 3 story, 62 x 110 ft. garage on Portland Heights for P. Weisinger, 555 Davis St. Estimated cost $1,000,000. Equipment detail not reported.

Pa., Allentown—The Bd. Educ. will receive bids until April 10, for heating and ventilating system in new school on St. Cloud St., for which general contract was just awarded. Estimated cost $45,000. Jacoby & Everett, Commonwealth Bldg., Engr.

Pa., Jeannette—The Amer. Window Glass Co., Farmers' Bank Bldg., Pittsburgh, will soon award the contract for the construction of a 1 story, 42 x 160 ft., 42 x 102 ft. and 48 x 84 ft. gas producer, boiler and power house, here. Estimated cost $250,000. L. J. Pierce, Farmers' Bank Bldg., Pittsburgh, Company Engr. Private plans.

Pa., Phila. — R. Beard, Shubert Bldg., Archt., will soon receive bids for the construction of a 4 story, 55 x 108 ft. apartment house on 39th and Walnut Sts. Estimated cost $500,000. Owner's name withheld. Equipment detail not reported.

Pa., Phila.—L. H. Cahan & Sons, Walnut & Juniper St., plans the construction of a 12 or 15 story, 176 x 230 ft. apartment house on 19th and Chestnut Sts. Estimated cost $6,000,000. Engineer or architect not selected.

Pa., Phila.—C. Kahn, Morris Bldg., is having plans prepared for the construction of a 15 story, 150 x 225 ft. office building, including steam heating system, on Broad and Catherine Sts. Estimated cost $1,500,000. L. B. Rothchild, 215 South Broad St., Archt.

Pa., Phila.—The Stanley Co., c/o The Hoffman Henon Co., Finance Bldg., Archt., will soon receive bids for the construction of a 2 story theater and office building on 52d and Chestnut Sts. Estimated cost $500,000. Equipment detail not reported.

Pa., Pittsburgh—The Amer. Window Glass Co., Farmers Bank Bldg., W. L. Monro, Pres. and Genl. Mgr., is in the market for one steam engine, ten mechanically operated heavy duty type gas producers, three sets automatic stokers, water heaters and two 350 g.p.m. hot water pumps.

Pa., Wilkes Barre—The Mallow Hotel Co., c/o R. H. Mallow, Pres., plans the construction of a 130 x 180 ft. modern theatre and hotel building. Theatre to have 2,000 seating capacity. Estimated cost $1,000,000. Engineer or architect not announced.

Tex., Denton—The State Legislature has passed bills making appropriation for the construction of an administration building for the North Texas Normal College and a heating plant for the College of Industrial Arts, here. Estimated cost $300,000 and $110,000, respectively. Engineer or architect not announced.

Tex., Perryton—Attorney General's Dept., Austin, approved $35,000 bond issue for the construction of an electric light plant. Noted Jan. 2.

Tex., Texas City—The Texas Sugar Refining Co. plans the construction of a sugar refinery. Estimated cost $5,500,000. Private plans.

Tex., Wills Point—The city, H. Gilchrist, Mayor, will hold an election April 3, to vote $25,000 bonds for the construction of a municipal electric light plant.

Va., Culpeper—The Culpeper Creamery Co. is in the market for machinery for dairy and several motors, 5 to 25 hp.

Va., Norfolk—J. B. Porter, P. O. Box 255, machinery dealer, is in the market for a 75 hp. stationery engine and a 100 hp. return tubular boiler.

Va., Norfolk — The Taylor-Parker Co., P. O. Box 1183, C. A. McLean, Purch. Agt., is in the market for a 150 hp. return tubular boiler and a 125 hp. Corliss engine, 22x 42 ft.

W. Va., Charleston—The Kanawha Investment Co. will soon award the contract for the construction of an 8 story, 130 x 190 ft. office building. Estimated cost $500,000. Carmichael & Millspaugh, 67 East Long St., Columbus, O., Archts. Equipment detail not reported. Noted Aug. 22.

W. Va., Moundsville — Marshall Dairy Products Co. is in the market for 35 hp. gas engines and a 15 ton ice ammonia compressor.

W. Va., Wheeling—The city, C. H. Dowler, City Mgr., will receive bids until Apr. 4 (change of date) for intake pier, intake line; substructures and superstructures for a 20,000,000 gal. filtration plant and pumping station; heating plant; filter equipment; sluice gates; distributing mains; valves; cast iron pipe; 30 in. steel and cast iron force mains; five 1,000,000 gal. storage tanks; appurtenances. J. N. Chester, Union Bldg., Pittsburgh, Pa., Engr. Noted Mar. 6.

Wis., Hartford — The Kissel Motor Car Co., W. Kissel, Vice Pres., is receiving bids for an 8 in. steam jet ash conveyor. Cahill & Douglas, 217 West Water St., Milwaukee, Engrs.

Wis., Madison—The Madison Electric Co., J. St. John, Mgr., 120 East Main St., is receiving bids on equipment for extension of addition to power house, including 1,000 hp. boiler, piping, etc. Mead & Seaston, Journal Bldg., Engrs.

Wis., Manitowoc—The Manitowoc Public Utilities Comn., City Hall, W. C. Staeffler, Secy., is in the market for two forced draft underfeed side dumped type automatic stokers; one belt driven fan; two vertical steam engines for drawing sand; two registering steam flowing meters; two feed water regulators; two automatic draft regulators; coal and ash handling equipment with crusher, conveyors and hoppers. F. Alber, City Engr.

Wis., Milwaukee—The Bd. of Industrial Educ., 7th and Prairie Sts., A. O. Muehl, Secy., will receive bids until Apr. 5 for one engine generating set, consisting of a uniflow engine directly connected to 300 kw., 110 to 240 volt generator. Private plans.

Wis., Phillips—The city, C. F. Scheel, Clk., plans to build a pumping station, sewer and water mains. Estimated cost $40,000. Engineer not selected.

Wis., Port Washington — The city, J. Kaiser, Mayor, plans to install a central heating plant and system including new boilers, etc., in present water and light plant. Estimated cost $125,000. Engineer not selected.

Wis., Rhinelander—The Rhinelander Electric Power Co., E. A. Forbes, Mgr., is having plans prepared for the construction of a 32 x 50 ft. power house. Estimated cost $40,000. Mead & Seaston, Journal Bldg., Madison, Engrs. Equipment to include 1,337 kva. vertical type waterwheel driven generator, and 1,725 hp. waterwheel.

Wis., Three Lakes—The Twp. of Three Lakes, H. M. Olkowski, Clk., is receiving bids for furnishing material and constructing approximately 10 miles of high voltage transmission line and a street lighting system. Cost exceeds $40,000. Private plans.

Wis., Tomahawk—The Tomahawk Kraft Paper Co., F. P. Stone, Pres., McCrossen Bldg., Wausau, plans the construction of a power plant and dam at Nigger Island near here. Engineer not selected.

Ont., Ottawa — The Dominion Government, Dept. of Public Wks., is having plans prepared for the construction of a printing bureau. Estimated cost $500,000. R. C. Wright, Dept. Public Wks., Archt. Equipment detail not reported.

Ont., Ottawa—The Ottawa Hydro-Electric Comn., 75 Laurier Ave., W., J. E. Braun, Supt., will receive bids until Mar. 30 for meters, transformers, wire and general supplies.

Ont., Woodstock — The city council, J. Morrisson, Clk., passed a bylaw for raising $25,000 for electric light and power extensions through the city. Wire, poles, transformers, switches and insulators will be required.

Que., Manseau—Savoie & Cie., J. Savoie, Purch. Agt., are in the market for two boilers, 5 to 6½ diameter, 10 to 14 ft. long, 150 lb. pressure; one 200 to 250 hp. engine.

Que., Montreal — R. P. Du Trembley, Drummond Apts., is having plans prepared and will receive bids until April 15 for the construction of a 10 story, 250 x 375 ft. apartment building on Drummond St. Estimated cost $5,000,000. Architect not announced.

Que., Rimouski—The Lower St. Lawrence Power Co., J. A. Brillant, Pres., plans the construction of 80 miles, 33,000 volt, high tension power line from Rimouski to Mantane; also a generating station at Priceville.

T. H., Pearl Harbor — The Bureau of Yards & Docks, Navy Dept., Marine Barracks, plans to install $30,000 worth of refrigerating equipment.

CONTRACTS AWARDED

Calif., Antioch—The City awarded the contract for furnishing centrifugal pumps and motors for waterworkc system to Antioch Electric Co., Antioch, $2,987; concrete tanks to the G. H. Field Co., Antioch, $12,340. Bids for pipe, fittings, flow meter, etc. rejected. Noted Mar. 20.

Calif., Oakland—The State awarded the contract for the construction of power house, recreation building, etc., at the Adult Blind Home, to F. W. Maurice, 1362 East 25th St. Estimated cost $45,760. Noted Feb. 27.

Kan., Smith Center—S. C. Walker will build a 3 story, 40 x 100 ft. warehouse and cold storage plant by day labor; later will install a refrigerator system. Estimated cost $50,000.

Mo., Kansas City—The Amer. Ice Co., Agnes and Guinotte Sts., awarded the contract for the construction of a 1 and 2 story, 80 x 127 ft. ice plant at 2730 Tracy St. to Collins Bros., 160 Grand Ave., Kansas City. Estimated cost $57,000.

Mo., Leeds—The Blue Valley Ice & Storage Co. awarded the contract for the construction of a 1 story, 100 x 100 ft. ice plant to J. Gosling, 242 Railway Exch. Bldg., Kansas City. Estimated cost $30,000.

Wis., Madison — The city awarded the contract for furnishing air lift equipment and pump, complete with Booster tank for city water supply to the Wisconsin Foundry Co., 627 Main St., $2,120. Noted Feb. 13.

Okla., Pryor—The Grand River Power & Development Co., Chicago, awarded the contract for the construction of a dam, 40 ft. high, across Grand River to form a reservoir covering 5,000 acres; power house, 12,000 hp. ultimately 30,000 hp. to the Taylor-Dewey Contg. Co., Allentown, Pa. Estimated cost $1,500,000.

Ore., Susanville—The Gem Mining Co. has been granted a permit for 10 sec.ft. of water from the John Day River and will build a log and timber dam, 1½ miles of ditch, 2,500 ft. of 12 in. pipe, and install a double nozzle, 225 hp. impulse wheel. The owner is in the market for wheel and pipe.

Pa., Meyersdale—The Meyersdale Electric Light, Heat & Power Co., J. E. Wilmoth, Pres., will build 25 x 35 ft. addition to power house. Equipment includes one 400 hp. watertube boiler, etc. Noted Jan. 16.

Wash., Prosser—The Horse Haven Irrigation District, had surveys made, plans completed, estimates made and agreement with Warren Bros. Co., Parkman Bldg., Boston, Mass., to construct system and dispose of bonds. The project consists of diverting the waters of the Klickitat River at the foot of Mt. Adams in Klickitat County and leading it through 80 miles of main canal to lands in Twps. 6, 7 and 8 N., Ranges 22, 23, 24, 25, 26, 27 and 28 E. in Benton and Yakima Counties between the Yakima and Columbia Rivers. Main canal—10 x 20 ft. to carry 1,600 sec.ft. Vel. 7.5 ft. per sec., concrete lined. Steel syphons—7.5 ft. 30 places, 28,000,000 steel. Grading, earth 2,700,000 cu.yd. Loose rock 814,000 cu.yd. Solid rock (Columbia Basalt) 1,602,000 cu.yd. Distribution system—grading 3,200,000 cu. yd. earth, 103,000 loose rock and 16,000 cu.yd. solid rock, 3,000,000 ft. of concrete pipe for general distribution to the lands. Authorized issue of $32.000.000 bonds, are issuing $28,000,000. Potential power development in connection with the project 100,000 hp.

Wash., Spokane — The Washington Water Power Co., 825 Trent St., awarded the contract for the last 22,500 hp. unit of plant, consisting of turbine, 4,000 volt, 3 phase generator, switchboard transformer connections and pent stock; hydraulic machinery to W. Cramp & Sons Ship & Engine Bldg. Co., Richmond and Norris Sts., Philadelphia, Pa.; electrical equipment to the General Electric Co., River Rd., Schenectady, N. Y.; penstock to the Willamette Iron & Steel Wks., Front and Nicholai Sts., Portland, Ore. This is the last unit of 90,000 hp. plant to develop hydroelectric power on the Spokane River below Spokane. The plant will have four 22,500 hp. 4,000 volt, 3 phase generators directly connected to the turbines, with step up transformers stepping to 4,000 volt, to 60,000 and 110,000 volt for line transmission.

Wis., Peshtigo — M. L. Webber, 1160 Emerald St., Madison, will build by day labor, addition to hydro-electric power plant and dam on Peshtigo River. Owner will purchase equipment. Mead & Seaston, Journal Bldg., Madison, Engrs.

B. C., Waneta—The Waneta Power Co., Ltd., awarded the contract for the first 4,000 hp. unit of 400,000 hp. hydro-electric and nitrogen fixation plant on the Pend D'Oreille River just north of the International Boundary to Mettleton, Bruce & Ashbaugh, Amer. Bank Bldg., Seattle, Wash. Estimated cost $300,000. The work consists of construction and equipment of plant on the Pend D'Oreille River, but taking its water from the Salmon River (a tributary); building a transmission line to Yunir and the Sheep Creek mining district, 30 miles north. The plant will then be able to furnish power for construction work on the main dam and plant, to use the water of the Pend D'Oreille River. Noted Nov. 14.